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### **Committee on Energy and Natural Resources for Development**

#### **Second session**

New York, 14-25 August 2000

Item 2 of the provisional agenda

#### **Adoption of the agenda and organization of work**

#### **Provisional agenda**

1. Election of officers.
2. Adoption of the agenda and organization of work.
3. Review of the reports of the Secretary-General prepared for the eighth session of the Commission on Sustainable Development dealing with the issues of integrated planning and the management of land and water resources.
4. Outcome of the seventh and eighth sessions of the Commission on Sustainable Development.
5. Strengthening and coordination of the activities of the United Nations system in the field of water resources.
6. Key issues related to the integrated planning and management of land use, ecosystems and freshwater development, use and protection, with special emphasis on the impact of the quantity and quality of shared waters of riparian States.
7. Follow-up to the first session of the Committee.
8. Contribution to the ninth session of the Commission on Sustainable Development and its preparatory process.
9. World energy assessment report: its implication for sustainable energy policy development.
10. Review of salient trends and issues on energy development and use in the context of sustainable development:
  - (a) Energy and the residential sector;
  - (b) Renewable sources of energy, with special emphasis on solar energy;



- (c) New financial mechanisms and economic instruments to speed up the investment in sustainable energy development;
  - (d) Promising strategies and initiatives to accelerate the development and implementation of sustainable energy technologies;
  - (e) Coordination of energy activities within the United Nations system.
11. The multi-purpose use of hydro resources.
  12. Provisional agenda for the third session of the Committee.
  13. Adoption of the report of the Committee on its second session.

## **Annotations**

### **1. Election of officers**

In accordance with rule 26 of the rules of procedure of the Economic and Social Council, the Committee, as a subsidiary body of the Council, shall elect its own officers. The Committee may wish to elect a Chairman, Vice-Chairmen and Rapporteur(s), taking into consideration that the Committee comprises 2 sub-groups of 12 members each, 1 dealing with issues of energy and 1 dealing with issues of water resources.

### **2. Adoption of the agenda and organization of work**

The provisional agenda of the Committee was approved by the Economic and Social Council by its decision 1999/277 of 28 July 1999.

### **3. Review of the reports of the Secretary-General prepared for the eighth session of the Commission on Sustainable Development dealing with the issues of integrated planning and the management of land and water resources**

The Committee will have before it the report of the Secretary-General on progress made in providing safe water supply and sanitation for all during the 1990s, which was before the Commission on Sustainable Development at its eighth session (24 April-5 May 2000). The report provides up-to-date information on water supply and sanitation coverage around the world, evaluates the progress made in attaining the ultimate goal of providing safe water supply and sanitation for all, and provides proposals for further actions.

## **Documentation**

Report of the Secretary-General on the progress made in providing safe water supply and sanitation for all during the 1990s (E/CN.17/2000/13)

The Committee will also have before it the report of the Secretary-General on issues related to the spatial planning of land (including minerals) and water resources, which was before the Committee at its first session and which has been revised in the light of the comments made by the Committee at that session on issues for inclusion in the report (see Economic and Social Council resolution 1999/47, annex).

**Documentation**

Report of the Secretary-General on issues related to the spatial planning of land (including minerals) and water resources (E/C.14/2000/2)

**4. Outcome of the seventh and eighth sessions of the Commission on Sustainable Development**

The Committee will hear an oral report on the outcome of the seventh and eighth sessions of the Commission on Sustainable Development.

**5. Strengthening and coordination of the activities of the United Nations system in the field of water resources**

The Committee will have before it a report providing information on the technical cooperation activities of the agencies of the United Nations system in the field of water resources undertaken since 1998, touching on the evolution of technical cooperation in water resources and lessons learned over the past decade.

**Documentation**

Report of the Secretary-General on technical cooperation activities of the United Nations system in the field of water resources development (E/C.14/2000/10)

**6. Key issues related to the integrated planning and management of land use, ecosystems and freshwater development, use and protection, with special emphasis on the impact of the quantity and quality of shared waters of riparian States**

At its first session, in 1999, the Committee decided to prepare for its second session an inter-sessional issue paper addressing key linkages and strategic issues related to an integrated approach to land use, ecosystems and freshwater resources.

**Documentation**

Inter-sessional issue paper on integrated water resources management: reconciling the interests of water use, land use and ecosystems (E/C.14/2000/3)

**7. Follow-up to the first session of the Committee**

The main decisions and recommendations of the Committee and the follow-up to the decisions of the Committee and related initiatives will be reviewed.

**Documentation**

Report of the Secretary-General on the follow-up to the first session of the Committee on Energy and Natural Resources for Development: energy sector (E/C.14/2000/7)

**8. Contribution to the ninth session of the Commission on Sustainable Development and its preparatory process**

Upon review of the report of the Ad Hoc Open-Ended Intergovernmental Group of Experts on Energy and Sustainable Development on its first session, the Sub-group

on Energy may wish to consider a further contribution to the ninth session of the Commission on Sustainable Development.

**Documentation for information**

Report of the Ad Hoc Open-Ended Intergovernmental Group of Experts on Energy and Sustainable Development on its first session (E/CN.17/2000/12)

**9. World energy assessment report: its implication for sustainable energy policy development**

The World Energy Assessment, prepared by the United Nations Development Programme, the Department of Economic and Social Affairs of the United Nations Secretariat and the World Energy Council, as part of the preparatory process for the ninth session of the Commission on Sustainable Development, is being published on schedule, after expert review of its second draft and a number of regional outreach programmes for consultations on the Assessment.

**10. Review of salient trends and issues on energy development and use in the context of sustainable development**

**(a) Energy and the residential sector**

Increases in population, urbanization and per capita incomes will contribute to the growth in energy demand in the residential sector. Within the residential sector, there are four principal uses of energy: climate control (heating, of both space and water, and cooling of space), cooking, lighting and appliances. Rising real incomes will result in increased penetration of energy-intensive appliances. Transportation energy use for private mobility is not included in the study.

**Documentation**

Report of the Secretary-General on energy and the residential sector (E/C.14/2000/8)

**(b) Renewable sources of energy, with special emphasis on solar energy**

The Committee will have before it a review of the potential and promise that solar energy holds in addressing the challenge of energy for sustainable development and, especially, providing basic energy services for nearly 2 billion people still without access to modern energy services. The current status of utilization of solar energy worldwide is also reviewed with emphasis on solar photovoltaics, including (a) rate of growth of deployment and contribution to national or local energy balances, (b) savings in carbon dioxide emissions, (c) goals and targets, (d) government-driven, donor-driven and market-driven developments, and (e) strengths and weaknesses of current approaches covering policy, institutional and entrepreneurial capacity, and societal issues.

**Documentation for information**

Report of the Secretary-General on renewable sources of energy, with emphasis on solar energy (E/C.14/2000/9)

**(c) New financial mechanisms and economic instruments to speed up the investment in sustainable energy development**

Financing is a key issue worldwide, in the development of sustainable energy resources, and will most probably become the dominant issue in the development and use of renewable energy sources. In developing countries, severe constraints are likely on the financing of sustainable energy development, considering the very limited financial resources of those countries, competition from other, needier national investments and, not least, increasing privatization. The direction and focus of energy financing to developing countries by multilateral institutions are reviewed.

**Documentation**

Report of the Secretary-General on financial mechanisms and economic instruments to speed up the investment in sustainable energy development (E/C.14/2000/4)

**(d) Promising strategies and initiatives to accelerate the development and implementation of sustainable energy technologies**

The Sub-group on Energy may wish to deliberate on this issue, and the results of the discussion will be reflected in the report of the Committee on its second session.

**(e) Coordination of energy activities within the United Nations system**

Cooperation in the field of energy within the United Nations system has been undertaken on a formal basis since 1998. The Ad Hoc Inter-Agency Task Force on Energy has facilitated coordination of energy activities and has been successful in its initial efforts, especially with regard to establishing a common system-wide approach to energy and sustainable development, and facilitating communication and exchange of information on a regular basis.

**Documentation**

Report of the Secretary-General on the coordination of energy activities within the United Nations system (E/C.14/2000/6)

**11. The multi-purpose use of hydro resources**

The status of hydroelectricity generation worldwide is reviewed. There remains a huge potential for hydroelectricity generation in developing countries. However, ecological concerns and other environmental and social issues remain to be resolved.

The item will be considered jointly by the two Sub-groups.

**Documentation**

Report of the Secretary-General on the status of hydroelectricity generation (E/C.14/2000/5)

**12. Provisional agenda for the third session of the Committee**

The Committee will have before it a note by the Secretariat on the provisional agenda for the third session of the Committee and the documents to be submitted under each item.

**13. Adoption of the report of the Committee on its second session**

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# Economic and Social Council

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## Committee on Energy and Natural Resources for Development

Second session

14-25 August 2000

### Issues related to the spatial planning of land (including minerals) and water resources

#### Report of the Secretary-General

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## I. Introduction

1. The present report has been prepared in accordance with Economic and Social Council decision 1996/306 and resolution 1999/49. It is based on a previous report of the Secretary-General on this topic (E/C.7/1998/5) which was considered by the Committee on Energy and Natural Resources for Development at its first session, held from 5 to 16 April 1999,<sup>1</sup> and subsequently submitted for the consideration of the Council at its substantive session of 1999. The Council, in its resolution 1999/49 of 28 July 1999, requested the Secretary-General to prepare a revised version of the 1998 report for submission to the Committee at its second session. The Council also requested that the report be made available as a background document on integrated land management to the Commission on Sustainable Development at its eighth session.

2. In accordance with the guidelines set out in resolution 1999/49, section III of the report identifies current and emerging issues in the area of land and water resources management. Section IV analyses particular problems in relation to land and water and the need for an integrated approach and action. Section V puts forward recommendations for improving the spatial planning of land and water resources.

3. In the annex to resolution 1999/49, the Council requested the Secretary-General to take into consideration paragraphs 13 to 30 of the inter-sessional strategy paper (E/C.7/1996/6 and Corr.1) of the former Committee on Natural Resources, wherein concern is expressed that the efforts to implement the recommendations of United Nations water and environment conferences, such as the United Nations Water Conference (Mar del Plata, Argentina, 1977), the International Conference on Water and the Environment (Dublin, 1992) and the United Nations Conference on Environment and Development (Rio de Janeiro, Brazil, 1992), have not kept pace with demonstrable needs to address issues of water and land degradation. This has serious implications for society as a whole and the life-support systems on which it is based. Issues of water quality, water quantity, urbanization and land have profound implications for society, including human health, food security, economic production and biological diversity.

## II. The context of degrading land and freshwater resources

4. *The fixed and finite nature of land.* The Food and Agriculture Organization of the United Nations (FAO) Interdepartmental Working Group on Land Use Planning defines land as "... a delineable area of the earth's solid surface, embracing all attributes of the biosphere above and below the surface, the soil and underlying geology, the hydrology, plant and animal populations and human settlements, and the physical results of past and present human activity".<sup>2</sup> The total land area of the world is estimated at about 13 billion hectares, over half of which lies in developing countries. According to FAO estimates, only one tenth of the land area in these countries is currently used for crop production, and much of the agricultural land in industrialized countries is already in production. It is also estimated that 90 per cent of potential new cropland is located in the developing world, of which 95 per cent lies in Africa and South America, while the remaining 5 per cent lies in Central America and the Middle East. Virtually no land is available for expansion in Asia. In addition, productive land is continually being lost to soil erosion, waterlogging and salinity and then partially reclaimed through remedial soil conservation and drainage. In many instances, a considerable proportion of this "land reserve" is under forest or in protected areas and is not readily available for agricultural expansion. In fragile tropical and upland environments, forests and their associated productivity are critical elements in sustaining the asset value of land and water systems and maintaining the flow of economic benefits and environmental services that are derived from them. As a consequence, there is currently limited scope for increasing food production through the expansion of cultivated land area. Meanwhile, the degree to which grain-dependent nations can rely upon imported supplies is also tempered not only by the relatively limited volume of internationally traded grain, but also by the infrastructural constraints to grain distribution. This maintains imperatives for degrees of domestic self-sufficiency and places continual pressure on fragile land resources.

5. *The limited and vulnerable nature of freshwater resources.* The quantity and quality of water flowing across the world's landscapes are inherently limited and vulnerable. The implications for economic

development and the overall environmental integrity of the world's surface water and groundwater systems have been recognized for the past three decades. The Commission on Sustainable Development at its sixth session reaffirmed these concerns on the basis of the report of an expert group meeting held in Harare, in January 1998.<sup>3</sup> The spatial variability of land characteristics combined with the spatial and temporal variability of rainfall poses particular challenges for assuring the flow of consumptive and non-consumptive water services that are derived from the freshwater resource base. The modification of natural hydrological regimes through agricultural practices, withdrawals, diversions, flow regulation and pollution will always induce environmental and economic externalities downstream or down-gradient. There is also increasing call for the in situ values associated with watercourses and aquifers to be maintained not only to preserve amenity and biodiversity values, but also to sustain critical human uses that depend upon maintaining water levels and annual flooding regimes — the productivity of wetland forests is a case in point here.

6. The allocation of scarce water resources among competing uses has fundamental effects on human welfare, socio-economic development and the protection of ecosystems. The provision of adequate amounts of water for basic human needs should be incorporated into the formulation and implementation of policies for water resource development and allocation. In this context, the equitable and sustainable allocation of water resources is an essential element of rural and urban development strategies aimed at poverty alleviation through generation of employment, income and productivity. Such strategies should be based as much as possible upon community participation at the lowest appropriate levels, taking into particular account the role of women in rural and urban communities as ultimate managers of water resources in both household and agricultural use. Such approaches require specific policies to improve local institutional capacity and promote human resources development. Economic evaluations need to consider positive and negative impacts on both human and ecosystem health. To the extent that subsidies are required to maintain public health and equitable access, they should be clearly targeted to the intended beneficiaries and aligned with rural development strategies. Additional funding, targeted mainly to peri-urban and rural areas, may also be required to implement such strategies. The integration of water

resources development and management with land-use planning is also essential to promote stabilization of rural populations through the alleviation of rural poverty and promotion of local employment opportunities in the productive use of water and land.

7. *Reaching critical environmental limits.* The degree to which human activity has resulted in degraded land and water systems is well documented in all regions of the world. It is now evident that critical physical limits have been exceeded in instances of wholesale degradation of land systems and irrevocable damage to surface and groundwater systems. Accelerated land and water degradation, including dryland salinity and groundwater pollution, are all occurring at unprecedented scales and intensities and are particularly marked where the pressures of population growth coincide with naturally vulnerable ecosystems. These instances can occur at various scales and can range from, for example, over-withdrawal of freshwater lenses in small island atolls to felling of mountain forests to wholesale reversal of saline balances at the level of shared international river basins. With the exception of massive hydraulic structures, in all cases it is the accumulation of many distributed and highly localized land and water management decisions that tip the balance between natural systems that maintain a degree of integrity and systems that break down.

8. *Spatial aspects of physical and socio-economic linkages.* Land and water systems are intimately linked as much through their physical relationships as the socio-economic settings that depend upon them. The spatial expression of these links is significant since the position of any resource or activity will have implications for down-slope and down-gradient components and the respective users. Of particular concern to the spatial planning is the complex array of human systems of rights over land, its natural attributes and associated natural systems, water in particular. These socio-cultural and political divisions that are spread over naturally occurring physiographic divisions pose particular problems for spatial planning on the basis of the resource itself and have, in many instances, constrained planned development.

9. *Agricultural land-use.* According to recent FAO estimates, while arable land may expand by 90 million hectares by 2010, the harvested area could increase by 124 million hectares through improved cropping intensities, with irrigated land in developing countries

expanding by 23.5 million hectares from the current 186 million hectares. As a result of intensification of land use in areas that are naturally well endowed or can be made so by economically viable human activities, such as irrigation and drainage, there will be a significant decrease in the average rate of land per rural household in the near future. Per capita availability of arable land in developing countries is projected by FAO to nearly half between the late 1980s and 2010, from 0.65 to 0.4 hectares, and that figure is likely to decline even further towards 2050, when the possible adverse impacts of global climatic change on food security may become more accentuated. By contrast, the per capita amount of arable land may increase in industrialized countries given their relatively stagnant population growth. This is likely to lead to the more marginal arable lands being taken out of production as "set-aside" lands to conserve natural systems and provide amenity and recreational values. In addition, approximately half of the 1.8 billion hectares of land in developing countries (excluding China) with rainfed crop potential is located in humid areas (that is, too wet for most crops and rather unhealthy for human settlement) or is considered only marginally suitable for crop production. The possibilities for expansion of land for crop production are therefore relatively limited. Nonetheless, it is generally accepted that world food supplies will have to double between 1995 and 2025 because of continued population growth and expected rises in income. However, in view of the constraints on future land supply, unlike previous decades when expanded land area and increased irrigated area played a major role in increasing agricultural production, most of the rise in future production is expected to come from increased productivity, that is the intensification of production with high-yielding crop varieties rather than changes in water management.

10. *The specific spatial impact of mineral exploitation.* Petroleum, mining and smelting industries have created local environmental effects throughout the world, and in the past have led to acute or chronic pollution of soils and surface and groundwater systems. The effects of mineral exploitation depend upon a variety of factors, such as the chemical composition of the minerals, topography, methods of mining (open pit or underground mining), hydrological conditions and climate, but it is often the case that the environmental effects of mining often extend far beyond the mining site. This is particularly the case for impacted surface

and groundwater systems, but it also applies in cases of windblown dust and air pollution. The most serious problem is the release into the environment of harmful trace elements and heavy metals, such as lead, cadmium, arsenic and mercury, which may not only pollute local and regional water resources but can also degrade large land areas, major aquifers and eventually coastal areas. Harmful concentrations of metals can also build up in associated plant and animal life and move up the food chain to affect human health. Heavy metal pollution of water has a number of anthropogenic sources, including mining, processing of ores and particularly leaching from industrial waste dumps and mine tailings. Acidified or saline water enhances metal mobility and draws more heavy metals from mine tailings. It also transforms such metals as lead into a form more readily absorbed into living tissues, thus amplifying the toxic effects of leaching. Pollution of groundwater due to leaching processes, particularly in areas with sulphide ore deposits, can be especially serious since reclamation of the affected aquifers is technically demanding and expensive.

11. *Spatial aspects of land and water degradation.* The impacts of human activity on land and water systems come into sharp focus when the environmental balance breaks down irretrievably as a result of accelerated erosion, salinization, groundwater pollution and other processes whose damage goes well beyond the original source of degradation. Anthropogenic degradation in the form of erosion, salinization, waterlogging, depletion of fossil groundwater, pollution by non-degradable chemical substances, acidification and eutrophication have socio-economic consequences that include a decrease in land productivity for long periods of time and the need to implement costly restoration programmes. The sequential impacts of specific environmental "shocks", such as deforestation, are often manifold, unleashing a cascade of soil, water and geochemical impacts. Soil degradation is the most ubiquitous manifestation of environmental breakdown. Its aggregate economic impact is significant because (a) it undermines productive agricultural systems, (b) natural recuperation may take decades or centuries, and (c) artificial soil rehabilitation is often very expensive. FAO has estimated that one fifth of current irrigated land in the world is already degraded to the extent that crop reproduction is significantly reduced. The impact of deforestation in fragile tropical environments is exposing linked land water ecosystems to ever-increasing degradation. The

role of forestry in land use and in land management techniques should therefore not be underestimated in view of the growing interdependency of forestry and agriculture in the lives of rural communities.

### III. Situation analysis: current and emerging management issues

12. *The status of spatial planning for land and water systems.* The role of "master planning" has diminished in the last two decades as shifts from central economic planning to decentralized and participatory forms of governance have occurred. The implementation of master plans has continued in developing countries, but there is very little evidence of master plan updates and reiterations. Meanwhile, the use of productive floodplains and also marginal lands with fragile soils and geotechnical constraints for habitation and agriculture has intensified. Natural system limits have been exceeded in many cases both at local levels and at broader regional/system levels since the mechanization of farming and pumping in the first half of the twentieth century. The risks associated with the development of these land categories are becoming increasingly apparent as major flood events, earthquakes and forest fires impact on human settlement in these risk-prone zones. It should be noted that even without a long-term commitment to spatial planning, the technical tools to plan, implement and monitor physical plans (such as satellite surveillance and geographic information systems technology) have advanced dramatically and have become cheap in relation to other planning and implementation costs.

13. *Separation of natural processes and human impacts.* The separation of human impacts and naturally occurring processes is often difficult to determine and attribute with any precision, particularly when the negative environmental externalities accumulate away from the source of the impact. Natural change can be catastrophic, and although human influence on land and water resources can significantly alter natural regimes in many regions and settings, these impacts have to be evaluated against the background of natural processes, such as erosion and geochemical cycling.

14. *Impact of urbanization and changing demographic structure of rural areas.* Many developing countries are experiencing drift of young mobile populations to urban areas. This trend is well documented in United Nations publications.<sup>4</sup> Economic growth and urban

development will lead to further competition among various users for scarce land and water resources. Agriculture will continue to be the most important economic sector and represent the most important user of these resources in many developing countries, including some countries with limited availability of water resources. Hence, policies and programmes affecting the allocation of land and water among competing uses can have a profound impact on urban and rural development, and on the generation and distribution of economic benefits. While the impact of urban dwelling is relatively well recognized and monitored by national authorities, the implications for the demographic structure of rural populations are less certain, but given that it is often the young mobile rural populations that are drawn to urban areas, the human capacity to maintain traditional land management techniques, such as terracing and drainage, is becoming progressively reduced.

15. *Institutional responses.* In general, it is possible to observe that the use of land and water systems entails limited enforcement and compliance of sound natural resource policies. There has often been an overall reliance on structural solutions (for example, increasing storage and flood protection) and a reliance on purely administrative solutions (such as the closure of factories). Despite the current state of affairs, there are some positive aspects that are important to note. Comprehensive policies and enabling legislation (including many detailed regulations) are in place in many countries making a commitment to natural-resource-based policies, but implementation lags behind, impeded as much by the political sensitivity of land and water rights as by the sheer complexity of managing linked natural and socio-economic systems. As had been indicated, land and water issues are multidisciplinary in nature and encompass a large number of other environment and development issues. Although these clearly call for an integrated approach, such issues are often addressed independently through economic sector management and administrative domains. This commonly results in duplication and waste of financial, human and institutional resources and can avoid addressing symptoms and causes across naturally integrated spatial units, catchments, aquifers and river basins. However, the experience with the implementation of natural resource based policies as opposed to sector policies has been limited to a few innovative countries. In general, the vested interests in sector-based policy are often too strong or entrenched

to allow complete commitment to integrated land and water management.

16. *Land tenure and water rights.* The wide variation in systems of rights and tenure over land and water resources presents a major hurdle for spatial planning of land and water. Disputes between traditional (common law) systems of land and water rights and modern administrative systems of land and water are profound.<sup>5</sup> This is the case not only for many developing countries that are highly dependent upon subsistence and commercial farming systems, but equally in more developed regions.<sup>6</sup> As pressures for access to productive land increase, particularly in areas where options to migrate to urban centres are limited, the need to resolve both the political and the structural planning issues becomes more acute. For instance, access to rural credit, agricultural inputs and markets can hinge upon both a recognition of land titles and the availability, *inter alia*, of the necessary infrastructure, rural banks, feeder roads and irrigation delivery. Systems of land and water rights should to a greater extent respect and balance prior common law and also take into account the spatial framework of river basins and aquifers. The degree to which progressive legal reform can promote the sustainable engagement with the natural resource base is as much a question for spatial planners as it is for the drafters of the legislative code.

17. *The valuation of natural resources and environmental services.* The social, economic and environmental values associated with land and water systems are often unrecognized and undervalued. The common property conception of land and associated surface and groundwater resources (irrespective of their legal status — which varies considerably) make the application of traditional economic methods and tools problematic. The use of land and water resources invariably produces externalities that are difficult to capture in conventional market transactions.<sup>7</sup> Therefore, the notion that some form of regulation is required to protect the public interest in the resource base is generally accepted.

18. *The knowledge base.* All countries are facing various degrees of land degradation problems and examples of progressive practice in land and water management can be found in different climatic and physiographic zones. In addition, numerous international conferences, publications and national experiences have provided basic frameworks on which

to build effective management plans. The role of geographic information systems technology in monitoring and planning spatial changes in land-use and resource management is now playing a broader role in environmental monitoring and planning as computing systems and software become both more sophisticated and less expensive.

19. *Lagged application of technology.* The report of a panel of the Commission on Science and Technology for Development studying science and technology for integrated land management (E/CN.16/1995/4), submitted as a background document to the Ad Hoc Inter-sessional Working Group on Sectoral Issues (see E/CN.17/1996/6) at the fourth session of the Commission on Sustainable Development, concluded that most of the scientific knowledge and applied technology needed for effective land resources management are available. The same is true for water management, and it is likely that countries with such problems may not be applying this knowledge effectively owing to limited access to information and appropriate technologies, lack of adequate infrastructure to use available technology efficiently and institutional fragmentation, which result in uncoordinated approaches and efforts, lack of scientific and educational capacity, problems caused by current land-use practices and unresolved conflicts between different land-use goals. In addition, the lack of human financial and organizational resources in many countries prevents people from actively participating in environmental management and policy development.

#### **IV. Problem analysis: the need for integrated action**

20. *The range of the problem.* The economic productivity of land and water systems has been limited as much by inherent limitations of the systems as by poor management and there is a continuum of actions required at all levels in order to move towards overall sustainability of land and water resources. At the global and regional levels, issues to be addressed include desertification, drought and flood management, as well as other issues related to natural disaster preparedness and prevention. At the regional level, there is also scope for actions to control transboundary pollution of soil and water, cooperation in the conservation and use of international waters (rivers, lakes and groundwater) and river basins, and the

transfer of technology and know-how. At the national level, there is a need to implement policies to promote the sustainable use and management of land and water resources, including with regard to the identification of clear rights to land and water resources. Significant action also needs to be taken at local levels, where local development plans should aim at efficient and sustainable use of existing resources, protection of resources from quality degradation, and strengthening of local participation, especially by women and the poor, through education and public awareness campaigns and greater opportunities for local participation in planning and decision-making processes. A number of issues need to be addressed to ensure an effective integration of land and water resources management.

21. *Causes.* The root cause of land and water degradation is excessive land and water use, emanating from excessive demand in relation to actual supply of resources. The increasing demand and relatively decreasing land and water resource base have resulted in an intensification of competition among various uses in space and time. The whole issue is severely complicated by the population growth, particularly in areas with inherently limited land and water resources. The intermediate causes are twofold. First, the institutional arrangements are fragmented, which calls for integration of approaches. There are few examples of single agencies responsible for the overall environmental health of the land and water resources. Second, with the exception of countries that can, in the short term, import substitute agricultural produce and desalinate and distribute sea water, the economic substitutes for these critical resources are not readily available. However, the prime proximate cause of degradation remains the operational land and water management at the local level, which may not conform to declared policies or may not be subject to any policy direction at all.

22. *Identification of gaps.* It is the intermediate and proximate causes that can be addressed in the short and medium term through clearer articulation of policies and improved implementation. Specific gaps that can be identified and which can be negotiated include:

(a) Lack of incentives for integrated natural resource management policies (the economic argument);

(b) Lack of coherent spatial constituencies at the level of the natural resource base (stakeholders);

(c) Lack of working systems of basin governance (implementation);

(d) Lack of accountability and risk-sharing;

(e) Continued reliance upon structural solutions;

(f) Poor or impeded information flows and lack of relevant information.

23. *Sector-based or natural resource-based management?* The incentives for integration across sectors and jurisdictions are not always made clear since the economic externalities (both positive and negative) generated by the use of the natural resource base can be felt away from the point of use. In this sense, it can be argued that an integrated rather than a sectoral approach is essential to reconcile competing interests and optimize resource use. However, the complexity of valuing natural resource systems over time and space constrains the presentation of explicit economic arguments. It should also be noted that the existence of strong sectoral entities and interests, is not, in itself, sufficient reason to fail to adopt integrated approaches. Efficient coordination across sectors can be achieved if economic and financial incentives are presented to the sector players through an administratively strong resource manager. Here, it is the integration of sector policies and interventions across natural resource units that is critical. This is particularly the case for competition between urban and rural land uses. This conflict can be expressed in various forms, such as (a) expansion of human settlements, industrial areas and peri-urban infrastructure versus protection of prime agricultural land and secure agricultural land tenure, (b) mass influx of rural poor to urban areas versus adequate availability of labour for agricultural activities (or conversely, urban unemployment), (c) competition between urban and rural water use, and (d) urban demand for timber and charcoal versus vegetative protection of upper catchments to prevent the degradation of agricultural land and water resources.

24. *Natural resource constituencies and systems of rights.* It is increasingly clear that conventional options for purely administrative solutions to land and water management appear to have reached their limits. A consensual approach to natural resource management is thus becoming an increasingly attractive solution for

resolving tensions between owners, managers and regulators of resources. However, dealing with complex natural and socio-economic systems will always involve a measure of compromise over the spatial "rules of engagement". Here, the legal status of the natural resource (whether common, public or private) and the system of rights that has developed over time can be difficult to resolve. The "perfect" right to land as a static resource is easier to administrate than user rights over water that flows above or below a bounded area of land. In general, there is a lack of clear, steady boundaries in the water resource flow domain (both surface water and groundwater) that can conform with the generally precise administrative and jurisdictional bounds in the public domain — the so-called "solutions of continuity". While natural resource specialists are always seeking to define physical boundary conditions, these boundaries are, by their nature, dynamic — changing over time and space — and are not generally closely monitored. For instance, the typical "solutions of continuity" that would apply in the regulation of watercourses (catchments and basin boundaries) and the "natural monopoly" conditions that apply in the provision of water services from single sources, such as rivers or dams, are not easily validated for aquifer systems and their multiplicity of users. Equally, if the effects of all groundwater withdrawals fell within accepted and precise administrative solutions (for example, "rules of capture" related to property boundaries), there would be no problem, but this circumstance can rarely be proved to apply. These considerations make the identification of natural resource constituencies, as opposed to administrative constituencies, difficult in both technical and political terms and can thwart attempts to organize around naturally integrated land and water management units.

25. *Effective systems of natural resource governance.* Formulation of integrated land and water policies is constrained by the political realities and sensitivities surrounding, on the one hand, bounded property claims and on the other, access to and use of a common property resource — water. The range of sectoral interests is such that it is very difficult for one institutional agency to undertake overall responsibility for natural resource management. But there are clear opportunities for the formulation of strategic approaches to land and water degradation improved implementation through efficient sectoral coordination. Single natural resource agencies can only be effective

here if they have clear mandates and are able to offer compelling incentives to change local systems of land and water management.

## **V. Actions to improve and enhance the spatial planning of land and water resources**

### **A. Integration of land and water resources management into national socio-economic strategies**

26. *Spatial frameworks for reconciling interests.* Effective land and water resources planning, development and management needs to be integrated into overall national economic and social planning and strategies. This can only be done at the appropriate spatial level if there is broad agreement to reconcile interest in the framework of functional natural resource units, river basins, aquifers or homogenous physiographic zones that include a grouping of basins and aquifers with similar characteristics.

27. *Improved economic analysis and incentives.* Estimating the full economic value, including environmental and amenity assets, of land and water poses particular problems, and a range of solutions have been employed by economists and their respective institutions. Some examples on how to place a value on the public good benefits of water are discussed in a recent World Bank report.<sup>8</sup> Economic valuation of water-related investments in development and management of irrigation, hydropower, urban and rural water supply and sanitation, drought prevention and flood control is important because it aids in determining the worth to people of proposed projects and in estimating the degree to which they are willing to pay for benefits. In the prevalent situation of constrained public budgets, conceptually correct and empirically valid estimates of the economic contribution of both land and water in each water-using or land-use sector are essential for making economically sound investment decisions.

28. *Structured approach to "stakeholder participation".* Any policy formulation and implementation need to involve a constituency of stakeholders as early as possible in the process, and should include those that are affected by any action, those who possess knowledge and expertise and those who control the

relevant instruments for successful implementation of policies and actions. It is important that public consultations and feedback are carefully structured to avoid special interests crowding out legitimate voices and to demonstrate that the results of the consultation are squarely internalized by policy and decision makers.

29. *Specific links to agricultural production.* Intensive competition for productive land and limited raw water resources is now becoming a feature of economies dependent upon high contributions from agricultural output. Under these circumstances, agriculture and irrigation policies have to be set into a broader frame of sustainable development to stress the long-term sustainability of food production systems, particularly in relation to soil and water conservation and the role of traditional agricultural practices. For example, the role of shallow groundwater in sustaining rural communities and providing a buffer against annual drought will remain critical in many arid and semi-arid areas but often needs protection from overexploitation by dominant agricultural interests.

30. *Specific links to health.* With water as a primary agent in maintaining both human health and transmitting disease, there is an imperative need to manage land and freshwater sources to maintain chemical and biological quality to minimum acceptable standards. Key actions that will work towards the protection and improvement of water quality include (a) priority for sanitation, sewage treatment and control of discharges of industrial effluents and run-off of pesticides and fertilizers, (b) monitoring of bacteriological and parasitic water-borne diseases at the basin level, and (c) prevention or minimization of contamination of land and water by heavy metals, such as mercury used in artisanal mining.

31. *Protection of vulnerable ecosystems.* The balance between environment and development needs to be founded on a clear understanding of the environmental systems and the resources that they can furnish without compromising their overall long-term integrity. The economic implications of environmental degradation and failure to anticipate climatic variability can account for significant percentages of gross domestic product in lost productivity. As mentioned above, a number of environmentally sound development policies to avoid or mitigate damaging impacts on land and water ecosystems have been formulated by various national and international bodies, including the body of

recommendations related to the implementation of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, the Convention on Biological Diversity, the Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (Ramsar Convention) and the Convention on the Law of the Non-Navigational Uses of International Watercourses.

## **B. Institutional and legal frameworks for effective governance of land and water systems**

32. *Establish clear principles of natural resource management.* Worldwide, there are four common threads to be found in dealing with integrated planning and management of land and water resources. First of all, a stable institutional framework that overcomes fragmentation and overlap of responsibilities, supported by comprehensive but flexible legislation and regulations, must be in place. This ensures fairness in basin-wide decisions and a process of accountability. Second, planners and stakeholders should have access to a strong knowledge base grounded in an accurate and comprehensive data network that allows the formulation, implementation and follow-up of sustainable natural resources development strategies. This ensures equity in defining solutions among and between the implementing agencies and water users. Third, various natural resource issues should be fully integrated into coherent administrative frameworks, which implies that responsible agencies have to take into consideration the whole natural resource spectrum of possible positive and negative environmental impacts. It also means that provincial and regional governments should look at their natural resources base as a whole and attempt to achieve sustainability as a package, as opposed to attempting to maximize the use of a single resource, such as water, soil or minerals. Last but not least, a programme for strong community awareness and participation should be fully implemented. Most policies or decisions relative to the rehabilitation or exploitation of natural resources have a large impact on users, especially farmers. Unless the end-user understands these issues and is able to measure his or her behaviour in relation to local sustainability indicators, users cannot be expected to forego short-term gain in pursuit of long-term sustainability.

33. *Address the problem at the appropriate scale.* In order to implement integrated land and water policies, countries need to define appropriate spatial and temporal scales, at both the national and local levels, for the formulation and implementation of relevant development and conservation programmes, including monitoring systems. It is important to recognize that, although the basic problems of land and water management have many similarities around the world, local variations in the physical environment and economic and social conditions require that technological and managerial solutions be adapted to local conditions. For instance, basin management approaches developed for small-scale basins or sub-basins may not be suited to large-scale basins. It is important, however, that national (and to some extent regional) planning take into account the scale of natural resources units — river basins, aquifer systems or coherent physiographic zones. As a first step, this can be done within existing institutions, by coordinating planning strategies and adapting them to the required spatial level. Establishing a focal point within national and subnational administrations would facilitate this process. In addition, there is a need for political initiatives and economic incentives that promote consultation and coordination among the actors. Despite the fact that interdepartmental coordination within national and local administrations would be an important step in making land and water management planning more efficient, the efficient integration of land and water resources may require the establishment of specialized agencies that have specific responsibilities for planning across administrative and sectoral jurisdictions.

34. *Make provision for implementation through local management.* Local management institutions need to be given a high degree of responsibility over the planning and use options of land and water resources under their jurisdiction, including the resolution of disputes among competing water and land uses, particularly where economic instruments either have failed or cannot be applied. If not already available, an inventory of local land and water resources should be compiled, and the economic, social and environmental requirements of all stakeholders need to be identified. The role of local farming and water user associations is becoming increasingly recognized here and they clearly need to be encouraged to engage in the planning process. Accommodating these special interests in an open and transparent planning process is desirable and

potentially can be an effective route to sustainable development.

35. *Build requisite capacities.* The relevant chapters of Agenda 21 recognize that many of the problems related to land and freshwater have arisen from a lack of adequately trained personnel, public awareness and education about the protection of surface and groundwater resources. Since extension services have traditionally been provided by sectoral institutions without proper coordination, starting to build the institutional capacity to deliver integrated services at the field level requires, above all, both high-level ministerial policy coordination and appropriate financial and human resources. Applying a multidisciplinary mix may need a refocusing of efforts at intermediate institutional levels and extensive retraining of extension officers. These efforts should ideally be supported not only by international, national and local support agencies, but also by the private sector and various non-governmental and scientific organizations. The strengthening of institutional capacity also requires a strong educational, research and analytical infrastructure, primarily based on local and national expertise. Educational capacity needs to be built from a strong base, including primary education. At the national level, considerable efforts need to be made to promote the understanding of the interaction between land use and management on the one hand, and quality and flow regimes of river systems and groundwater on the other. This is particularly important in rural areas, since non-point sources of pollution, including fertilizers and various toxic substances used in agriculture, are an increasingly serious problem worldwide. The scientific community, through universities and international organizations, has a responsibility to gather and present information that is accurate and comprehensive, and to provide practical assistance in the implementation of action-oriented programmes and initiatives. At the same time, Governments should promote and enhance the active participation of scientists in the policy and decision-making process.

36. *Promote public information campaigns.* As a complement to education programmes, public information campaigns are an important way of communicating with large groups in society. These campaigns should be based on information that is readily available and comprehensible to the general public, and should aim at promoting broad public

interest in environmental issues. It is important that such campaigns be presented in a positive manner, demonstrating possible development options of interest to people at the local level. The technical revolution within the information and communication media (principally the Internet) has enabled the cheap dissemination of vast amounts of information on land, water and other environmental issues. This, however, has not yet benefited many people in developing countries that presently lack the means to access these services. In order to be disseminated worldwide, assistance to develop national networks in developing countries is required to improve and enhance (but not replace) ongoing public extension programmes.

### **C. Mobilization of financial resources**

37. The mobilization of the financial resources to implement the land and water planning initiatives indicated above presents a set of challenges. Despite the fact that developing countries and countries with economies in transition have been working towards the sustainable financing of traditional subsectors, such as urban water supply and irrigation, they have not yet come to fruition. At the same time, they also face enormous financial, technical and institutional challenges in managing their water and land resources in a sustainable and integrated manner. The quality of the intertwined land and aquatic environment is a concern in all countries, but in many developing countries, the situation is acute. This is most obvious in cities where sewage and industrial effluents are rarely treated. There are also very major problems associated with inappropriate land and water use in agriculture. The financial resources required to deal adequately with these problems are often beyond the means of most countries. While official development assistance is an important source of finance in the poorest countries, in most developing countries, the bulk of investments required to tackle these problems will have to come from national sources. In order for this to happen, Governments need to foster an enabling environment that encourages investments from both public and private sources, and to allocate a significantly higher proportion of their budget expenditures to public investments in sanitation and sewage treatment in order to control the adverse environmental health impact on both land and water ecosystems. This will often include measures to ensure cost recovery of improved service provision. In fact,

greater attention needs to be given to the use of economic instruments, such as pollution charges and taxes on fertilizers and pesticides, to control the discharge of industrial effluents and non-point sources of pollution in agriculture. As discussed in a paper prepared for an expert group meeting on strategic approaches to freshwater management held at Harare in January 1998, it is possible to identify two major approaches to dealing with environmental standards and the costs required to achieve those standards. The first approach can be characterized as the "set-the-standards-and-then-raise-the-money" approach. The second approach is one in which environmental quality and the required financing are considered simultaneously.

### **D. Transfer and adaptation of technologies**

38. The efficient management of land and water resources is mostly a local or national issue, and will need to be defined for each area. Local and indigenous experience can be an important source of knowledge that is often ignored in traditional technical cooperation arrangements. Research into and adaptation of such knowledge for contemporary application can yield results that are cost-effective and sustainable. It is also important that technologies and training or education programmes be adapted to local conditions and local users. Appropriate technologies to improve land and water management exist, but their applications are limited by institutional and financial constraints, as well as lack of appropriate training and education. Transfer of technology is not automatically a solution to the underlying problems facing many countries, such as increased population pressure and land degradation, but it can be an important component in combination with many other actions that might be needed, including measures to ensure adequate operation and maintenance at the local level.

39. Technology transfer schemes should also recognize that ongoing technological development is often driven by commercial considerations, so that investment in further research and development can be properly funded. Nonetheless, the least developed countries that have not benefited from the increase in private capital inflow need special attention. To address this issue, priority could possibly be given to low-cost technologies and the use of local resources, including

raw materials, that could be promoted as environmentally feasible.

### **E. Enhanced information management and monitoring systems**

40. *Information for economic performance.* The continuous monitoring of environmental changes is crucial for economic and social planning at both the national and regional levels. The adaptation to changes (natural as well as human-induced) that take place in the landscape requires that information on such changes be periodically gathered and analysed. It is useful, however, to note that the financial costs of establishing, operating and maintaining monitoring systems can be high and beyond the means of many developing countries unless financial and technological assistance is provided. This calls for careful cost-benefit analyses that take account, *inter alia*, of the limitations of these systems and the possible benefits that they will provide, including (a) the provision of adequate and accurate information to decision makers, (b) the ability to detect changes in the landscape, including natural or human-induced disasters, so that appropriate measures can be taken to deal with them, and (c) the ability to detect natural and man-made disasters so that appropriate action can be taken to prevent them or the mitigating effects that follow them.

41. *Information for risk management.* Disasters, natural as well as human-induced, are often related to land and water systems, such as floods, droughts and mudflows. When they occur, there is a need for rapid and coordinated responses and actions from local, national and international organizations. If data and information are available and continuously updated, changes that may eventually cause irrevocable loss of productivity, such as deteriorating water and soil quality, critical changes in groundwater piezometric heads, topsoil loss, floods and mudflows, may be detected and action can be taken in advance. National and regional capacity to gather and evaluate information that is relevant to disaster prevention needs to be strengthened, including through international financial and technological assistance, if required. In this sense, the role of risk management for natural resources needs to be embedded in national policies and recurrent budget resources dedicated even when the short- and medium-term benefit of such investments may not be apparent.

42. *Promotion of exchange and integration of scientific information.* Any monitoring programme developed to study relationships between land and water needs to be cross-sectoral, both within the scientific community and between researchers and policy makers, in order to present a comprehensive set of policy options to decision makers. Comprehensive studies on the reasons behind poor land and water management practices should not only focus on physical constraints in the environment but should also examine pricing policies, land access issues, subsidies, taxes, environment laws, the role of land and water resources in economic and social development, local customs and indigenous knowledge. There is also a need to have an open discussion on further data needs and how to integrate information systems to better address environment issues related to land and water management. The question of addressing issues from a river basin perspective fall into this category. Governments and organizations have ambitious programmes but information, if available, is often scattered and sectoral, which makes it difficult to prepare detailed assessments and propose effective management strategies. It is also important to define data and information needs for each country and region within countries since areas with a complex and changing environment or where land use is intensive will require dense monitoring systems, while more homogenous and sparsely populated areas may require less coverage. The overall objective should be that countries and international organizations should enhance ongoing efforts, both national and international, to collect and analyse data and information about the physical, economic and social environment that can be applied to the watershed level (or any other appropriate spatial level). Financial and technical assistance should be given to developing countries to formulate and implement national programmes in the area of data collection, analysis and exchange. National geographical information systems should be particularly developed and supported, and their databases should be systematically updated and expanded, as required. Scientific cooperation among universities could be one step in the right direction. It could be possible from this system to retrieve information and data sets on physical, economic, social, and environmental conditions and parameters, and to integrate them at the desired spatial scale, for example covering a specific river basin or sub-basin.

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*Notes*

- <sup>1</sup> See *Official Records of the Economic and Social Council, 1999, Supplement No. 12 (E/1999/32)*.
  - <sup>2</sup> Food and Agriculture Organization of the United Nations and United Nations Environment Programme, "Negotiating a sustainable future for land: Structural and institutional guidelines for land resources management in the 21<sup>st</sup> century", Rome, 1997.
  - <sup>3</sup> See the report of the Expert Group Meeting on Strategic Approaches to Freshwater Management (Harare, 27-30 January 1998) (E/CN.17/1998/2/Add.1).
  - <sup>4</sup> United Nations *World Urbanization Prospects: The 1996 Revision*, United Nations publication (sales No. 98.XIII.6).
  - <sup>5</sup> D. A. Caponera, *Principles of Water Law and Administration*, Balkema, (Rotterdam, 1992).
  - <sup>6</sup> B. Barraqué, *Eurowater: Water Rights and Administration in Europe*, European Union D.G.XII Horizontal Report No. 8, 1996.
  - <sup>7</sup> National Research Council, *Valuing Ground Water: Economic Concepts and Approaches*, Committee on Valuing Groundwater (Washington, D.C., National Academy Press, 1997).
  - <sup>8</sup> Robert Young, "Measuring the Economic Benefits for Water Investments and Policies", World Bank Policy Paper, No. 338 (Washington, D.C., 1996).
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**Committee on Energy and Natural Resources  
for Development****Second session**

14-25 August 2000

Item 6 of the provisional agenda\*

**Key issues related to the integrated planning and  
management of land use, ecosystems and freshwater  
development, use and protection, with special emphasis  
on the impact of the quantity and quality of shared  
waters of riparian States**

**Integrated water resources management — reconciling  
interests of water use, land use and ecosystems****Inter-sessional issue paper***Summary*

At its first session, in 1999, the Committee on Energy and Natural Resources for Development decided to prepare for its second session an inter-sessional issue paper addressing key linkages and strategic issues related to an integrated approach to land use, ecosystems and freshwater resources. The work was entrusted to an open-ended ad hoc group of members, coordinated by M. Falkenmark (Sweden). The present paper provides a basis for discussions on how to support the input of the Commission on Sustainable Development to the 10-year review of the United Nations Conference on Environment and Development, to be held in 2002. The preparations were to build upon the results of a Stockholm International Water Institute/International Water Resources Association seminar on the theme "Towards upstream/downstream hydrosolidarity", held in Stockholm in August 1999. The present paper builds on the results of both that meeting and a Global Water Partnership seminar held in November 1999 in Stockholm on integrating ecological services into water resources management.

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\* E/C.14/2000/1.



The need to take an integrated approach in river basin management was stressed in chapter 18 of Agenda 21. As shown in the present paper, this should incorporate the deeply interwoven issues of water-dependent land use (including food production for the growing population), water use in many different societal sectors (for survival, health, energy production, income generation etc.) and crucial ecological services (chemical, such as denitrification; physical, such as enhancement of infiltration and groundwater recharge; and biological, such as pollination, seed dispersal, pest insect control, and fish and meat production).

The need for such an integrated approach, incorporating both land use and ecological services, was discussed at the two above-mentioned seminars. Their results have been incorporated as a basis for the present paper. Hydrosolidarity in an upstream/downstream context will have to include attention to both green water (water vapour flows) and blue water (liquid flow in aquifers and rivers); to land use, water use and ecosystems (terrestrial as well as aquatic); and to the need for reconciling conflicts of interests between water-impacting upstream activities and ecosystems and water-dependent downstream activities and ecosystems.

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## I. Background

### A. Input of the Commission on Sustainable Development to the 10-year review of the United Nations Conference on Environment and Development

1. Given world developments since the United Nations Conference on Environment and Development (UNCED), the input of the Commission on Sustainable Development to the 10-year review of the implementation of Agenda 21 will have to incorporate issues which have emerged since UNCED, in particular of experiences and results since the five-year review conducted in 1997.

2. The world is undergoing an extremely rapid change as regards humanity's relations to the freshwater resources on which socio-economic development and quality of life genuinely depend. Major driving forces are population growth, urbanization and industrialization. A key event in this context is the Second World Water Summit, held in the Hague in March 2000. Deep global concerns for the growing crisis were reflected in the World Water Vision and its accompanying Framework for Action, presented by the World Water Commission and the Global Water Partnership, respectively. The key concept in the follow-up will be water security through integrated water resources management.

3. The main message of the World Water Vision is that although much has been achieved, today's water crisis is already widespread. The provision of six times more water to society today compared with 100 years ago has had significant impacts on people and their environment. In that sense, the cup is half full. On the other hand, large deficiencies remain in terms of lack of sanitation, a large degree of undernourishment, widespread damage to natural ecosystems, heavy subsidies and sectorized management. That makes the cup half empty and means that it is imperative to take action, especially in view of the strong driving forces. The Framework for Action puts focus on the need to make water governance more effective by taking an integrated approach and putting integrated water resources management into practice. River basin management and transboundary agreements form essential components.

### B. Need for an integrated land/water/ecosystem approach

4. Agenda 21, in chapter 18, stressed the need for taking an integrated approach to water. It is not fully clear, however, what should be integrated, whether different sectoral uses of water, quantity and quality, land use and water resources, upstream and downstream activities etc. In recent years, it has become increasingly clear that the conventional approaches to water resources, concentrating on liquid water (blue water) in rivers and aquifers and on sectoral allocation of water, are becoming insufficient. Also, the water in the soil that makes land productive and returns to the atmosphere as part of the plant production process (green water) has to be considered as well.

5. The relationship between land use and water was addressed in a report submitted to the first session of the Committee on the spatial planning of land and water resources (E/C.7/1998/5). That report was a follow-up to earlier Committee discussions on land/water linkages. The report stressed that land use and water resources are closely intertwined. Therefore, the sectoral approach of the past has to be avoided. Under Economic and Social Council resolution 1999/49, the report was to be made available as a background document on integrated land management to the eighth session of the Commission on Sustainable Development after some complementary work as identified at the first session of the Committee.

6. Development work has also taken place within the Global Water Partnership, under which integrated water resources management has the central focus. Studies have been made on how to include proper attention to land use and protection of ecosystems in integrated water resources management. As part of these efforts, a seminar was organized in November 1999 at the Beijer Institute of Ecological Economics in Stockholm, with a focus on the inclusion of ecological services in integrated water resources management. Since the results of the seminar are of interest also to the Committee, they have been incorporated as a basis for the present paper.

## C. Upstream/downstream relations

7. In the prevailing conventional approach to water development and utilization in most if not all countries, more stress is laid on allocation between different sectors rather than upstream/downstream interdependency and interaction. However, in wise water resources management, upstream/downstream linkages have to be duly considered. Attention has to be paid to what happens to water quality after use since a degradation of quality may jeopardize development options and environmental sustainability downstream. Moreover, development opportunities and options of some countries or regions literally depend on a water source entering from another country upstream. At the same time, people in upstream areas have a legitimate claim on the basin resources within their sections of the basin.

8. There is obviously a need to discuss upstream/downstream relationships in two important aspects: (a) what are the water needs, the reasonable claims and the efficient and fair utilization of basin resources in the various parts of a basin, and (b) what kind of management system is required to deal with the threats of water quality degradation. The same principal problem is noticeable within river basins, whether in a national or international context. The difference is the added political dimension in the latter case. The Stockholm International Water Institute (SIWI) organized in August 1999 an international seminar on the theme "Towards upstream/downstream hydrosolidarity". Since they are of interest for the input of the Commission on Sustainable Development to the 10-year review of UNCED, the results are incorporated as a basis for the present paper. The present paper also draws on a report on national sovereignty and international watercourses prepared by Green Cross International (1999) and presented to the Second World Water Forum. The present paper will discuss, as a background to discussions at the second session of the Committee, what additional principles are needed to reach a level of water security that pays adequate attention to land use and ecological services in the river basin context, whether national or multinational.

## II. Where do we start?

### A. Water and land-use linkages

#### 1. Land-use conversions have water consequences

9. One fundamental problem is that the dominating conventional approach to water resources has its focus on water itself in view of the direct services that it provides to society. What is often neglected is more indirect services, such as water-driven plant production in rain-fed agriculture, pasture and forestry (FAO, 2000). This neglect has its origin in the temperate zone. In tropical climates, however, the evaporative demand is high, with a strong influence on the amount of water consumed (evaporated) per ton of biomass produced. This has led to the introduction of green water, i.e. water vapour flows. The liquid water flows in rivers and aquifers is referred to as blue water (see fig. 1).

10. Society benefits directly from both branches of the water cycle: from the green for biomass production (food, fibre, pasture, fuelwood, timber) and from the blue for water-dependent societal water uses (water supply, industry, irrigated agriculture, hydropower). It also benefits indirectly through a multitude of ecosystem services provided by both the green and the blue branches, to be further discussed below.

11. The reason that attention has to be paid also to green water flow is the close link between the green and blue branches of the water cycle. The link between vegetation and the vertical transport of water vapour first attracted wider general attention in the discussions around the climate change in the humid tropics in view of the possible influence from the clearing of tropical rainforests, with their considerable vapour flows.

12. Dry, low latitude countries with a warm or hot climate have come to realize the hard way that there is a close connection between the water vapour consumed in plant production and what remains of the rain to produce groundwater and river run-off. Australia suffers from large-scale water logging and salinization in response to the deforestation started by European immigrants. South Africa has even introduced a system of reforestation permits to be applied for by foresters with reforestation or afforestation in mind.

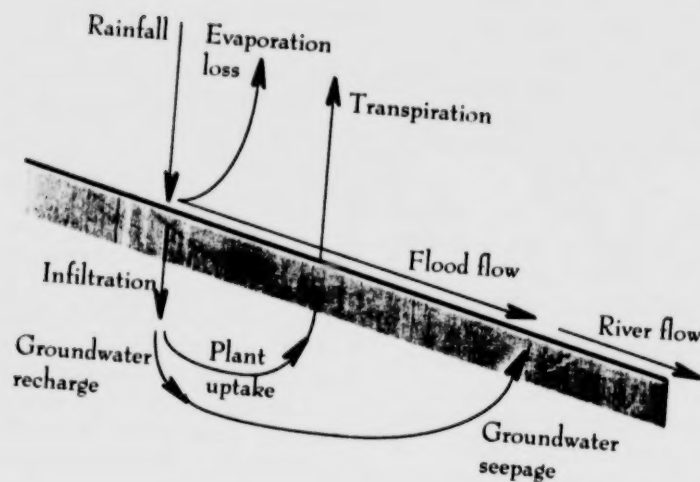


Figure 1

Rainfall, on reaching the ground, divides into two main branches: the vertical branch of green water flow (water vapour) and the semi-horizontal branch of blue water flow (liquid water) passing through aquifers and rivers

13. There are important lessons to learn from Australia: one should by all means avoid waiting for the crisis to develop before action is taken (Beijer Institute, 2000). The salinity trauma of Australia, now threatening the productivity of some 25-30 per cent of the arable land of the country, shows that the price to be paid might be very high. The lesson from South Africa is equally useful: the alien vegetation with high water demand invading the whole country is reducing the rainwater surplus, leaving 10 per cent less of its blue water earlier available to the country. This insight has made it more and more evident that what has to be shared between those upstream and those downstream in a river basin is not only the water currently flowing in the river, as codified by the Convention on the Law of the Non-Navigational Uses of International Watercourses of 1997, but also the rainfall over the river basin.

14. The complementarity becomes evident when addressing the need for rapidly expanded food production in regions where most of the farming is rain-fed. Upgrading rain-fed agriculture will call for improving both the infiltrability and water holding capacity of the soils by soil conservation and the water uptake capacity of the roots by protection from dry spell-related plant damage (Rockström and Falkenmark, 2000). Also, forestry has a clear effect on blue water production in dry-climate tropical countries. Typically, deforestation on the one hand increases the run-off due to a decreased green water flow, and on the other impermeabilizes the soil, thereby reducing groundwater recharge and thus dry season river flow (Sandström, 1995). The result is dry season river depletion, combined with wet season floods. It has been suggested that the recent massive flooding reported from Yang tse Kiang in China may reflect a combination of both these factors.

15. Many poverty-stricken dry climate countries with rapid population growth today rely mainly on rain-fed agriculture. A crucial question is to what degree more green water flow will have to be appropriated to allow the additional food production. At the same time, a green water increase may be equivalent to a blue water decrease, i.e., a river and/or groundwater depletion. What this boils down to is no less than an existential issue for humanity's future.

## **2. Manipulations of landscape components are unavoidable**

16. To satisfy societal needs for water, food, energy, goods and services, humans generally have to manipulate various landscape components (Falkenmark, 1997). Many manipulations are physical — soil permeability, slope, water courses, river flows, water tables etc. Others are chemical — on the one hand, agricultural chemicals leached to rivers and aquifers; on the other hand, waste products emitted to the atmosphere, reaching the ground as fall-out/wash-out, disposed onto the land, reaching rivers and aquifers through leaching, and emitted directly to water bodies.

17. Due to special properties of water, such manipulations will produce side effects, so-called "environmental effects". Some side effects are unavoidable, whereas others are avoidable (such as pollution from waste water). Side effects can occur as a result of:

(a) Changed water partitioning at the ground surface, influencing both the water flow down the catchment and the vapour flow to the atmosphere, and maybe even the vapour flow producing precipitation downwind;

(b) Water's function as carrier of solutes and silt, contributing to the transport of substances in the landscape and affecting water quality. The side effects manifest themselves in changes in water quality and quantity, with higher-order effects on water-dependent flora, fauna and biodiversity;

(c) Water cycle continuity generating chain effects from the atmosphere to the land and the terrestrial ecosystems, to groundwater, rivers and lakes and aquatic ecosystems, and to coastal waters and marine ecosystems.

18. Water quality problems tend to dominate in the temperate zone. River depletion may develop as a serious additional problem in low latitude regions with high evaporative demand. The fact that China's Yellow River in 1997 went empty seven months a year in its downstream part constitutes a serious reminder in this regard. In the past, water-generated side effects have often been considered as surprises and treated as unintended environmental impacts. With better understanding of the land/water linkages, land and water management should be seen as components of an

intentional ecohydrological landscape management, incorporating water uses, land uses and ecological services impacted by the necessary manipulations of land and water (Beijer Institute, 2000).

## B. Water-ecosystem linkages

19. Ecosystems are genuinely water-dependent. Some types are rainwater-dependent, such as grasslands, forests and bogs; others are groundwater-dependent, such as dambos; and others are surface water-dependent, such as riparian wetlands and floodplains.

### 1. Ecological goods and services

20. Ecological goods and services are provided by a complex of nested ecological systems, driven by solar energy under the influence of hydrological and biogeochemical flows, and in interconnection with other systems (FAO, 2000). Examples of ecosystem services include:

(a) Chemical services, such as oxygenation of the atmosphere, carbon sequestration and denitrification;

(b) Physical services, such as enhancement of infiltration and soil permeability;

(c) Biological services, such as seed dispersal, pest insect control, fish production and meat production.

21. Freshwater, functioning as the bloodstream of the biosphere, plays a key role in the generation of ecosystem services, aquatic as well as terrestrial. But at the same time, "the work of nature" modifies water flows. Moreover, human activities alter the interactions between freshwater and ecosystem services. Freshwater goods supporting the population in a city include such goods as timber, fibre, paper, crops and seafood. Other services are involved in "treating" the output from the city, such as the reuse of phosphorus in agricultural areas, the sequestration of carbon dioxide in agricultural areas, biodegradation in inland water bodies, natural wetlands and forests, and denitrification in natural wetlands.

22. These goods and services need a certain area for production, referred to as the "ecological footprint" of the city. But water flows also have to be involved to make the production of ecological goods possible. While the perceived water support needed per urban

inhabitant in the drainage basin of the Baltic Sea is only 440 cubic metres per year, the hidden water support is several orders of magnitude larger (Jansson et al., 1999).

### 2. Upstream versus downstream ecosystems

23. The linkages between water and ecosystems work in both directions (Beijer Institute, 2000). On the one hand, ecosystems tend to be water-impacting, sometimes contributing to redirections and changes in water flow and pathways and to quality transformations. On the other hand, water management/mismanagement have ecosystem consequences. Decisions on water use (e.g., irrigation, urban supply) or land use (deforestation, drainage of wetlands) will impact on water flows and thereby on species, habitats and ecosystems that are dependent on those flows. Societal activities are therefore deeply involved in producing ecological changes in both terrestrial and aquatic systems.

24. The ecological systems are hosted in a landscape and internally linked by flows of water in an upstream/downstream pattern. Accordingly, it is essential to distinguish between upstream ecosystems, such as forests or crop fields, which are involved in the rainwater divided between the evaporating part, the flood-flow part and the groundwater part, and downstream ecosystems, such as wetlands and water bodies, which are subject to water quality deterioration and river depletion.

### 3. Prerequisites for biodiversity protection

25. Habitats and ecosystems are always subject to change and are genuinely water-dependent. They may in fact be changed in many different ways — through rainfall changes, soil permeability changes, water pathway changes above and below ground, changes in water travel times, quantitative flow changes, seasonality changes, water table changes, changes in chemical composition etc. Protection of biodiversity is supported by an international convention. It has to be remembered that a certain species cannot be protected, however, unless its habitat, its food web and the capacity of the ecosystem to absorb disturbances is sustained (Beijer Institute, 2000). The species is generally at the end of long causal chains in which water, due to its many different functions in life-support systems on the planet, is involved at several of the component stages. Water is therefore a necessary

but not exclusive factor to pay attention to in ecosystem development and conservation. In the general debate of biodiversity and ecosystem conservation, much attention tends to be concentrated on the need to avoid direct, visible changes of wetlands and other ecosystems. However, attention must also be paid to indirect, invisible, creeping changes that are linked to water's movement and quality transformations as it moves through the catchment, above and below the ground surface.

#### **4. Wetlands: a tricky concept in integrated water resources management**

26. The concept "wetlands" tends to create misunderstandings among water professionals. The concept is clear from the biological perspective: biological behaviour is guided by water surplus and the presence of oxygen-rich and oxygen-poor conditions in parallel. "Wetlands", however, encompass a whole set of different types of landscape components. The water component may be of completely different origin (rainwater, groundwater, episodic floods, river water etc.). Three things are clear:

(a) Wetlands may develop in different parts of the catchment (coastal, riparian/flood plain, first order streams, peatlands, ponds etc.) and may therefore have rather different characteristics in terms of water origin;

(b) Protection of wetlands critically depends on a proper understanding of their hydrology, a fact well known to many wetland ecologists;

(c) Protection of wetlands is as much an issue of water quality as it is of water quantity. For instance, a sudden nutrient import will lead to significant ecological change.

#### **5. Identification of determinants and threats**

27. In order to be able to decide on ecosystem protection the relevant water-related determinants have to be clarified since they indicate the causal chain by which the ecosystems may be disturbed (Beijer Institute, 2000). These determinants include water flow, water pathways, flow seasonality, water table and water quality/chemical composition. They may be impacted by land use, by pollution load and by flow control and management measures. Figure II visualizes water-related causal chains between key ecosystem goods (biomass harvests) and services (biodiversity), at the target end, and human activities related to food,

water and energy supply and the generation of income, at the disturbance end. Two types of land and water manipulations are important:

(a) On the one hand, direct manipulations of water flows and quality (flow control, water withdrawals);

(b) On the other hand, indirect manipulations of water flow through changes of land and vegetation, thereby influencing soil permeability and rainwater partitioning and consequently also water flow.

It goes without saying that a successful protection of a certain ecosystem, such as a wetland, evidently depends on enough understanding of its water-dependence and what particular threats it must be protected from. Similarly, to protect a certain species, the habitat of that species has to be protected against invisible, creeping changes linked to its water-dependence.

### **III. What is to be done? — Awareness of necessary trade-offs**

28. Basically, the next generation will have to face the potential trade-off between freshwater for direct human needs, freshwater for the production of the additional food needed for a growing world population and the freshwater needed to support the ecosystems services needed for a sustainable society.

#### **A. Landscape as an asset for development**

29. The intimate linkages between water resources, water-dependent land use and water-dependent ecosystems discussed above makes it evident that sustainable socio-economic development will not be possible unless an integrated perspective is taken on all activities in a river basin, water-dependent as well as water-impacting. Freshwater flows, crop production and other terrestrial ecosystem services are interconnected and interdependent. As a consequence, land-use decisions are also water decisions. Consequently, the challenge is to manage our interconnected environmental assets in a fashion that secures their capacity to support societal development for a long time into the future (Beijer Institute, 2000). That will require conflicts of interest to be highlighted

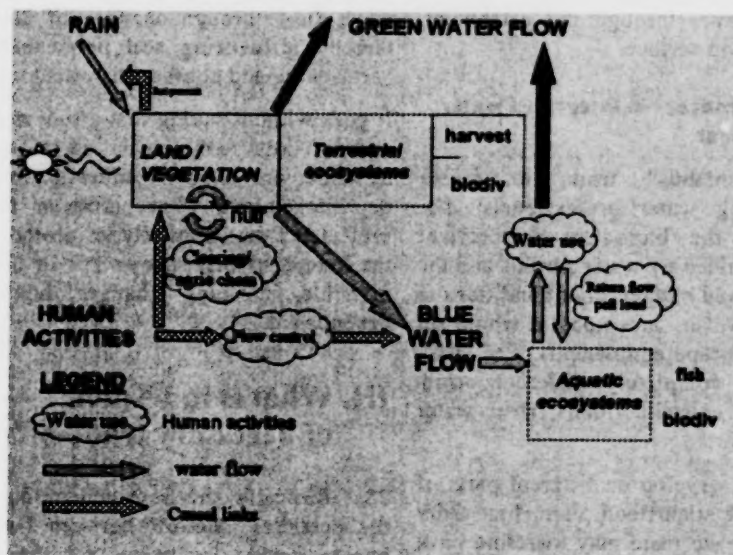


**Figure II**  
**Water-related causal chains between key ecosystem goods and services and human activities**

in specific cases. Trade-offs that are to be made between the use of water and land in river basins must build on a proper understanding of the eco-hydrological landscape.

30. Key questions to be raised include: How much water needs to be left in the river and why? What pollutants have to be avoided and why? How can key interactions between systems can be secured? How much rainfall needs to be captured by terrestrial ecosystems to secure ecological services?

### **B. Fundamental upstream-downstream trade-offs**

31. Basically, integrated water resources management, according to the definition used within the Global Water Partnership, involves coordinated development and management of water, land and related resources by maximizing economic and social welfare without compromising the sustainability of vital ecosystems.

32. Huge conceptual gaps between the water management profession and the environmental profession complicate the integrated approach (Falkenmark, 1999). Such conceptual differences have made it very difficult to arrive at a constructive dialogue. There is often a difference in the scale of approach: while the former have their focus on water in its role as landscape component, the latter often have their focus on individual species (a certain frog or butterfly) or biomes (natural reserves) that have to be protected. There is therefore a need for joint conceptual development of water professionals and ecological professionals so that they start to speak the same language and can enter into a true dialogue. Only in that way can the unavoidable trade-offs be properly addressed.

33. As already indicated, there is an important upstream/downstream dimension between land use, water and ecosystems and the various conflicts of interest involved, which have to be paid attention to in considering the unavoidable trade-offs. The upstream part of a catchment or river basin hosts a number of water-impacting activities: land use conversions, flow modifications and pollution load added. Together, they influence the river flow, seasonality and quality of the water flowing into the downstream part of the area. The downstream stakeholders are involved in a number

of water-dependent activities: both direct water use for households and municipalities, industry, irrigated agriculture etc. and ecological services within riparian wetlands, aquatic ecosystems and coastal ecosystems (see fig. III).

### **IV. How is it to be done? — Towards upstream/downstream hydrosolidarity**

34. Summing up the main points illustrated above, man's dependence on water is not merely a technical issue involving water supply and irrigation but a much broader issue since land use is not only water-dependent but also water-impacting. Therefore, upgraded water concepts are needed as a basis for conflict analysis and discussions. The river basin approach has to involve attention to direct and indirect freshwater services, as well as to water-related ecosystem services, terrestrial as well as aquatic. A fundamental challenge that will lead towards more sustainable socio-economic development is to find ways and means by which reconciliation can be developed between upstream and downstream activities, and between water interests, land-use interests and ecological interests. The starting point for such an approach has to be the rainfall over the river basin.

### **A. Land stewardship: a new task for the rural population**

35. The above-mentioned Global Water Partnership seminar concluded that one way of seeing the integrated water resources management/ecological services linkages is to manage catchments as an asset that delivers a bundle of water and ecological goods and services (Beijer Institute, 2000). Some of these services work in synergy, while others are in conflict. Hence, intentional trade-offs need to be made, based on the view of human as embedded in the eco-hydrological landscape. From the conclusion that the land has to be seen as an asset for human activities follows the notion that landowners should be entrusted the task of managing natural resources as a whole and possibly be paid for that. That would involve a new role — land stewardship — for the rural population,

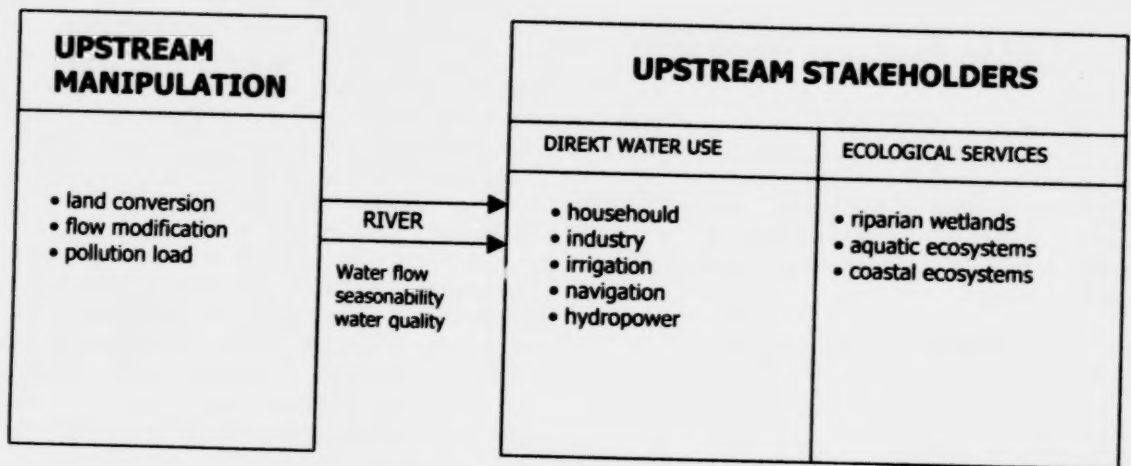


Figure III

Conflicting stakeholder interests in a river basin can be schematically systematized into water-impacting activities upstream, involving land and water manipulations and influencing water flow and quality, and water-dependent activities and systems downstream, influenced by water flow and quality characteristics

increasing their status. An interesting effort in this direction is the land-care movement in Australia. Ultimately, societal freshwater, land use and ecological services will have to be seen in a river basin perspective within a new hydrosolidarity thinking (SIWI, 1999). Upstream vegetation changes have flow consequences for downstream freshwater and ecological services. Upstream land-use changes and water uses involving the introduction of pollution loads will influence the quality of the water on which downstream activities and ecosystems depend. It is therefore essential to find ways to seek balance and compromises between upstream and downstream interests and ecosystems.

### **B. Mutual upstream/downstream considerations**

36. The World Water Commission, in its report to the Second World Water Forum, stresses that in accepting integrated water resources management need as a basic principle, one has to recognize that some 260 rivers are shared between two or more countries and that ways have to be found to minimize conflicts of interest, advocating best use of the water at the basin level. In fact, the effective management of water could become a vehicle for collaboration as much as its absence could be a potential source of conflict.

37. As stressed by World Water Council's Sovereignty Committee (Green Cross International, 1999), recognition of the interdependence of people in itself constitutes a step towards conflict prevention. National sovereignty over internationally shared water is best expressed through cooperation and effective interdependence between peoples and different interest groups. The report stressed that in transboundary watercourses, both internal and external manifestations of sovereignty are relevant. People depending on the water in an international watercourse need to be assured access to and a role in the management of this water by their state authorities. These authorities therefore have a responsibility to maintain an acceptable level of water quality and water quantity for those further downstream, and not to develop in such a way that States further upstream will be hindered in their future water utilization plans. The Committee therefore stressed that it is a misconception that state sovereignty is incompatible with inter-state cooperation.

38. Upstreamers will, in other words, have to pay adequate attention to the ways in which their activities influence downstreamers. This is an issue of water ethics. Downstreamers have to look out for the way that upstream activities may influence their water-dependent activities. This is an issue of national security. Also, downstreamers will have to practise water ethics: they will have to adapt their expectations to what will be realistic in terms of the constraints that those expectations will imply for upstream activities. They will also have to provide motivation for the upstreamers to constrain their activities, both in terms of the pollution load introduced and the water-consuming biomass production, i.e., activities that would otherwise pollute and/or deplete the river on which the downstreamers and their aquatic ecosystems depend.

39. The Convention on the Law of the Non-Navigational Uses of International Watercourses, although not yet ratified by more than some 10 States, provides guidelines and principles for the process of regional agreements. Key concepts in the doctrine include "no appreciable harm to other riparians", and "equitable and reasonable use" of the precious resource. At the above-mentioned SIWI/IWRA seminar, Wouters (1999) stressed that by levelling the playing field for all stakeholders, at all levels, and permitting the consideration of all relevant factors, the rule of equitable use is a valuable instrument that serves to prevent adversarial claims of hydro-sovereignty. Water law is relevant in defining, refining and applying the legal framework necessary to transform assertions of hydro-sovereignty into pacts of hydro-solidarity.

### **C. Three approaches to regional cooperation**

40. According to the Sovereignty Committee report (Green Cross International, 1999), basin-wide cooperation is the optimal solution to the problem of managing an international basin and, as means of moving towards this goal, any progress towards States and peoples working together to achieve more effective water policy should be encouraged. The report also indicates a number of possible perspectives on regional cooperation:

(a) Cooperation as "allocation" — mainly for water sharing purposes but lacking a holistic vision of the basin and inflexible to change;

(b) Cooperation as "salvation" — in order to avoid absolute disaster, either in the form of conflict or environmental destruction;

(c) Cooperation as "opportunity" — to reach concrete mutual benefits, possibly also encouraging cooperative action on other regional matters.

#### **D. Towards more sustainable agreements**

41. In the long run, ethical rules will have to be developed which complement the Convention. With change of population, urbanization, industrialization, socio-economic development etc. the landscape and river flow is going to change. Land-use changes will produce creeping changes in water resources: upstream consumptive use by altered vegetation systems (crop production, larger afforestation/reforestation schemes etc.) may involve a continuous river depletion. This means that the flow in the river which was the base for the original agreement decreases with time, so that unforeseen allocation problems develop not only between sectors in a river stretch but also between upstreamers and downstreamers. These ethical rules have to recognize the interdependence of water, land use and ecosystem function and services, such as that a land-use decision is also a water decision. The Convention takes a dominantly blue water perspective. A question for the Committee to discuss is how land-use conversions, with their effects on river flow in tropical regions, could be incorporated in upstream/downstream agreements based on that doctrine. Such agreements have to be sustainable and stand the test of time, including land-use changes to support a rapidly growing population and their effects. The strong driving forces at work in developing countries, escalating their water needs and landscape manipulations, makes the concept of "no appreciable harm" to downstreamers particularly difficult to adhere to.

#### **V. What should be done and by whom? — Implementation challenges**

42. As shown in the present paper, the conventional approach to freshwater problems is insufficient and needs to be revised on three fronts, each of which is interlinked:

(a) Sectoral aspects: land use, household and industrial use, and environmental impacts;

(b) Upstream-downstream dimension, national and international;

(c) Generic aspect: blue water and green water.

43. There is a broad understanding of the interdependency between the three sectoral aspects for sustainable development and on the need for integrated planning when dealing with water.

44. The upstream-downstream dimension is also very important. The national Government can, more or less efficiently, solve problems internally by arbitrating conflictual situations and imposing some kinds of action. Hydro-solidarity becomes an obligation and not simply a part of water ethics. On the international level, the dimension upstream-downstream can lead to a real crisis. The issue of national security becomes an issue of international security.

45. As for the importance of the upstream-downstream dimension at the international level, the situation has to be remembered of some 40 countries in which the availability of freshwater is heavily dependent on international inflows from neighbouring countries (such as Egypt, Hungary, Bulgaria and Botswana for 90-95 per cent of blue water availability). In spite of the conclusion of 300 agreements on common waters since 1945 (Wolf, 1997), there are still numerous international water conflicts that have yet to be solved. The 1997 Convention, which deals with allocation, pollution and the ecosystem aspects of water uses, is designed to help settle conflicts.

46. The United Nations worked for more than 25 years, particularly within the International Law Commission, to achieve the adoption of the 1997 Convention on the Law of the Non-Navigational Uses of International Watercourses. What has to be shared between those upstream and those downstream in a river basin, however, is not only the water currently

flowing in the river as codified by the Convention but also the rainfall over the river basin. As regards the sharing of rainfall, it would be useful to have some concrete principles and later a convention on that matter. The question "Who owns the rain?" has still to find an answer.

47. The green water role is complementary to the blue water. For some countries, the former is of paramount importance. But because of the mobility of water vapour and of the fact that some forests stretch over political borders, the question has also both national and international dimensions. It might be useful to draft a model law for countries to adopt (or to provide a basis for revising their national legislation), which takes into account agricultural use, domestic use and the environment, requiring the coordination between various ministries at the national level as well as land-use conversions and ecosystem protection.

48. The Committee may wish to discuss how and by whom:

(a) To make it possible to give the necessary attention to land/water/ecosystem linkages;

(b) To secure the implementation of such an approach.

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## Committee on Energy and Natural Resources for Development

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Item 10 (c) of the provisional agenda\*

**Review of salient trends and issues on energy development  
and use in the context of sustainable development: new  
financial mechanisms and economic instruments to speed  
up the investment in sustainable energy development**

## Financial mechanisms and economic instruments to speed up the investment in sustainable energy development\*\*

### Report of the Secretary-General

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## Introduction

1. Investment capital for sustainable energy is the scarcest resource in the developing countries owing to, *inter alia*, immature commercial capital markets and high demand for other priority investments and immediate needs. On the other hand, energy is a crucial component for social and economic development of countries. Owing to the complex nature and structural requirements of energy systems, large investment capital is required to develop the energy infrastructure. Furthermore, since sustainable energy technologies are not as mature as conventional energy technologies and the support infrastructure is also not well developed, the up-front capital and installation costs for sustainable energy technologies are higher than traditional fossil fuel-based energy technologies. Thus, the deployment of sustainable energy services in the developing countries will be a major challenge for the development community in the near and medium term.

2. The shortfall in modern energy supply in the developing countries is significant. It is estimated that 2 billion people in developing countries still do not have access to modern basic energy services or reliable electricity supplies for social and economic development. To meet this energy services requirement, substantial investments in energy systems are needed. An estimated \$100 billion to 300 billion per year for the next 20 years is required in the developing countries to meet the current shortfall in energy demand. Furthermore, if developing countries are going to leapfrog from traditional energy technologies to modern sustainable energy technologies, the needed investment capital will be even greater.

3. The financing of energy infrastructure projects in developing countries has been shifting from Governments, State-owned utilities and multilateral financial institutions to domestic and international private financial firms and energy companies. This shift is primarily attributable to the energy sector reforms that developing countries have been undertaking over the past decade with the encouragement of the multilateral institutions. In the reformed sector, the Governments of developing countries will play the role of setting policy, rules and regulations for the sector, while the private sector will finance, build and manage the energy infrastructure. With the increased flow of private capital for energy

financing to the developing countries, the multilateral institutions have focused more on technical, policy and institutional assistance than on direct lending in the liberalized energy market.

## I. Financing and investments

4. To assist the developing countries with the expansion of their energy sector, multilateral agencies offer concessional funds to supplement the shortfall in domestic investment capital. The World Bank group commitments in the energy sector during 1995 to 1998 fiscal year amounted to an average of US\$ 3.5 billion a year. In addition to traditional multilateral resources, specialized environmental funds are also available to assist in sustainable energy investments in the developing countries. The World Bank/Global Environment Facility (GEF) loans, credits, and grants over the period 1992-1997 totalled US\$ 275 million for renewable energy projects. The renewable energy components in the projects in the 1999-2001 pipeline include a total of approximately US\$ 900 million in World Bank and GEF support. The pipeline projects include the free standing renewable energy projects whereby energy service companies (ESCOs) in concession contracts will install over 100,000 solar home systems (SHS) in rural areas of Argentina, as well as the China Renewable Energy Development project which will install 190 megawatts (MW) of wind farms and 200,000 SHS in rural households.

## II. Investment policies in general

5. Policies to induce the flow of investment capital for sustainable energy technologies have been experimented with in a few countries and other policy instruments are being devised to accelerate the implementation of sustainable energy systems. In the United States of America, the Public Utilities Regulatory Policy Act (PURPA) promoted the installation of 9,000 MW of biomass-fuelled power generation in the 1980s as well as the development of wind power and to some extent solar thermal power generation. Targeted policies to increase the percentage of renewable energy in the power supply mix of utilities include the Renewables Non-Fossil Fuel Obligation (NFFO) in the United Kingdom of Great Britain and Northern Ireland and the Renewable Portfolio Standard (RPS) in the United States. These

policy instruments encourage an increase in the percentage of renewable energy in the power supply mix.

6. In China, a novel approach to granting wind resource concessions to project developers is currently being studied to speed up the development of wind power, while in Argentina, private companies will be invited to bid on concessions to provide electricity on a least-cost basis to off-grid dispersed rural communities. Further details on the policy instruments are described briefly below.

#### **The Public Utilities Regulatory Policy Act (PURPA) in the United States**

7. The PURPA, passed in 1978, requires that all utilities in the United States must buy electricity from qualified independent power producers (IPPs) at the avoided cost of electricity generated by the utilities. The Act provides IPPs with a secured market for its electricity and the ability to obtain power purchase contracts with predictable revenue streams. The introduction of the PURPA has successfully established an IPP industry and the deployment of renewable energy technologies in the United States.

#### **Renewable portfolio standard (RPS)**

8. The terms of the renewable portfolio standard (RPS) require that every retail power supplier provide a certain minimum percentage (or floor) of electricity from specified renewable sources for a given time period. A RPS may also include a credit trading system whereby suppliers can sell credits for the extra renewable power they have generated or vice versa. If they are short of renewable power, they can purchase credits to make up the difference in order to settle their account. Legislation establishing renewable portfolio standards has been passed in a number of States in the United States.

#### **Renewables Non-Fossil Fuel Obligation (NFFO)**

9. The United Kingdom Renewables NFFO also requires that electric utilities maintain a minimum percentage of their supply mix as renewable energy. The incremental cost between renewable energy and baseline energy is paid by the Non-Fossil Purchasing Agency with tax collected from utilities for the consumption of fossil fuels.

#### **Wind energy resource concession**

10. A wind resource concession for a designated region is issued by the Government in a competitive process to companies for exploration and development over a specified period of time. The Government will also issue the rules and regulations for the development of the resource and the sale of electricity to the power grid when requesting tender for the concession. The Chinese Government is currently assessing this approach to wind power development in China.

#### **Rural electrification concessions**

11. To provide electricity services to the dispersed rural population in north-west Argentina without extending the electric grid, concession contracts will be competitively tendered to ESCOs. It is expected that solar home systems, small wind turbines, and mini-hydro schemes will be competitive on a cost basis with diesel generators.

### **III. Investment capital**

12. Investment capital in the form of equity and debt and grant funds from development assistance sources may be obtained to finance sustainable energy projects. The three most common type of finance capital and the associated risk of each form are briefly explained below:

- **Equity:** high-risk financing that expects high returns. An equity investment can be made in a project or in a company carrying out the project. Equity investors maintain the right to become involved in the decision-making process of the project or company in order to protect their investment;
- **Debt:** medium risk with medium expected returns. In contrast to equity investors, lenders who provide debt financing to a project do not own shares in the project. They provide capital for the purpose of earning interest. Because lenders must be repaid before distributions can be made to shareholders, they bear less risk. For this reason, potential returns to lenders are limited to risk-adjusted market interest rates;
- **Grant:** no expected returns. Governmental and international organizations offer grants to promote environmental and development policies.

Renewable energy (RE) projects are often eligible for these funds.

### Sources of equity financing

13. Sources of equity financing include project developers, venture capitalists, equity fund investors, equipment suppliers, multilateral development banks, and institutional and individual investors (see tables 1 and 2). Their roles are described below:

- Project developers: a project developer initiates the project idea and usually invests the "up-front capital" that is necessary to develop a project from a concept to an actual project. The project developer usually leverages up-front capital inputs for a larger equity stake in the project. If the project developer retains ownership after the project becomes operational, the developer may be called an independent power producer;
- Venture capitalists: the venture capitalist specializes in investing in new companies. Because venture capitalists join companies in their earliest and riskiest stages, they expect to earn unusually high returns;
- Equity fund investors: equity funds provide investment capital in a project in return for a share of the equity of the project. The expected return on equity is generally two or more times greater than return on debt. In return for the higher expected yield, equity investors bear the greatest risks and have rights to distributions from the project only after all other financial and tax obligations are met;
- Equipment suppliers: reliable, experienced RE equipment supply companies often construct, install and operate RE systems but also offer equipment financing. In addition to turnkey system delivery and operation, the RE technology vendor may offer favourable financing terms;
- Regional development banks: these are regional development banks like the Asian Development, the Inter-American Development Bank (IDB) and the International Finance Corporation (IFC). These institutions not only provide debt financing, but can also provide minority equity financing;

- Institutional and individual investors: these are organizations or individuals who are willing to invest in projects on an equity basis in the hope of earning high returns on their investments;
- Joint ventures: in a joint venture project, a local and a foreign company may jointly invest to develop a project to meet local legislation on foreign ownership of companies and projects. The joint venture project may benefit from the comparative advantages and the financial equity that each company brings to the project.

### Sources of debt financing

14. These sources are described directly below:

- A principal source of debt financing is international and national commercial banks. Other sources of debt financing include multilateral development banks (MDBs) and IFC, international and national commercial banks, debt/equity investment funds, equipment suppliers, and private investors. These banks can play a major role by syndicating the debt financing of a major project among several banks so as to minimize their own risk exposure on a project;
- Subordinated debt is another form of financing which falls between debt and equity. Principally, subordinated debt is provided by a "friendly investor" or project partner and is subordinated to other primary debt in case of project default. In return, subordinated debt usually commands a higher interest rate than normal debt to reflect the higher risks associated with this investment.

### Sources of grant financing

15. Sources of grant financing include GEF, international and bilateral agencies, foundations, and national and local agencies. They are described below:

- Global Environment Facility (GEF): GEF has become an important source of grant financing especially for RE projects. One of the mandates of GEF is to support projects that help reduce greenhouse gas (GHG) emissions. As a result, many RE projects are targeted by GEF for support to help ultimately improve the

competitiveness of these projects in comparison with conventional fossil energy projects. GEF is the financial mechanism of the United Nations Framework Convention on Climate Change;<sup>1</sup>

- International and bilateral development agencies: many international and bilateral development agencies, such as the United Nations Development Programme (UNDP), the Netherlands Ministry of Development Cooperation (DGIS), the Danish International Development Agency (DANIDA) and so forth can and do provide grant assistance for RE projects;
- Foundations: a number of philanthropic agencies such as the Ford Foundation and the Rockefeller Foundation have, on occasion, provided grant funds for RE projects to help advance such projects in those cases where they have demonstrated environmental and social benefits;
- National and local agencies: in a number of countries, support for RE projects is also available from national and local agencies. A specific example is India where there is a Federal Ministry for Non-Conventional Energy Sources as well as State renewable energy development agencies.

**Table 1**  
**Multilateral development agency support for sustainable energy projects**

| Type of service                                        | World Bank | IFC <sup>a</sup> | MIGA <sup>b</sup> | RDBs <sup>c</sup> | UNDP <sup>d</sup> |
|--------------------------------------------------------|------------|------------------|-------------------|-------------------|-------------------|
| Feasibility studies/assistance for project development | X          | X                |                   | X                 | X                 |
| Equity investment                                      |            | X                |                   | X                 |                   |
| Debt financing                                         | X          | X                |                   | X                 |                   |
| Investment co-financing                                | X          | X                |                   | X                 |                   |
| Loan guarantees                                        |            |                  | X                 |                   |                   |
| Lease guarantees                                       |            |                  | X                 |                   |                   |
| Political risk insurance                               |            |                  | X                 |                   |                   |
| Technical assistance and training                      | X          | X                |                   | X                 | X                 |

<sup>a</sup> International Finance Corporation.

<sup>b</sup> Multilateral Investment Guarantee Agency.

<sup>c</sup> Regional development banks.

<sup>d</sup> United Nations Development Programme.

**Table 2**  
**Private sector investor support for sustainable energy projects**

| Type of service      | Commercial banks | Venture capitalists | Institutional investors | Individual investors | Equipment suppliers |
|----------------------|------------------|---------------------|-------------------------|----------------------|---------------------|
| Equity investments   |                  | X                   | X                       | X                    | X                   |
| Debt investments     | X                |                     | X                       | X                    |                     |
| Debt/equity swaps    | X                |                     |                         |                      |                     |
| Project co-financing | X                |                     |                         |                      |                     |
| Equipment financing  | X                |                     |                         |                      | X                   |

### Emerging financing models

16. A number of innovative financing models are emerging to help meet the growing demand for the financing of renewable energy projects. These innovative financing mechanisms are designed to overcome the principal barriers that RE projects face. A brief description of some of the emerging RE financing mechanisms is presented below:

- RESCOs/micro-utilities/cooperatives: RESCOs or renewable energy service companies along with concepts for micro-utilities or cooperatives are all designed to overcome two key barriers that small-scale RE projects face: high initial capital costs for end-users, and aggregation to reach a critical mass that is attractive for financing. The RESCO concept is most suitable for small-scale RE systems like photovoltaic (PV) solar home systems (SHS). Rather than sell SHS to homeowners, the RESCO sells the service (for example, lighting) that is produced by the SHS and in turn collects a monthly fee. This is very similar to what utilities do with electricity from their power plant. In this approach, the RESCO is responsible for owning, operating and maintaining the SHS while the consumer is responsible only for paying for the service. The RESCO, in turn, can aggregate a large number of consumers into a single project and seek financing for the project rather than for each individual SHS. The consumer overcomes the high cost barrier by having only to make small monthly payments;

- RE leasing companies: the RE leasing company concept is very similar to the RESCO approach with one key exception: the leasing companies are usually not responsible for maintaining and operating the RE systems. The leasing company approach helps overcome the high first-cost barrier; it helps as well to aggregate project financing and target it to a few business-oriented entities. This latter point is important for banks and investors. In addition, the leasing company approach provides certain tax benefits for a project which can help the financial attractiveness of the project;
- RE vendor credits: RE vendors are now recognizing what automobile and appliance vendors have known for a long time: providing credit to customers can help boost sales. RE vendors of both small- and larger-scale RE systems are now extending supplier credits to RE consumers and projects to help close financing gaps and in the process to help secure their sales. RE vendor credits can help overcome some of the perceived technology risks associated with many RE technologies. Consumers and project financiers are more likely to reduce their perception of technology risks if the equipment vendors are willing to back their products financially;
- Targeted project credits: multilateral development banks (MDBs) have recently used the approach of "targeted project credits" to supply financing through national and local banks for RE projects. In many cases, national and local banks may not be familiar with or willing to enter new markets or they may have limited financial resources and therefore service their traditional clients first. By targeting credits for RE projects, the MDBs have encouraged the national and local banks to explore these new and emerging markets. This approach has helped the national and local banks develop the knowledge and expertise for assessing similar projects in the future, thereby expanding their market base to include RE project financing. Targeted project credits help overcome the "no track record" financial barrier often faced by new and emerging technologies;
- Direct consumer credits: many low-income rural consumers do not have the ability to establish credit with which to purchase high capital cost RE systems. In these cases, the market potential for RE systems is severely limited. Attaching a consumer credit programme to the RE project will help extend the reach of the RE systems to a larger percentage of the market, particularly to those financially viable consumers who have no established credit or cash to purchase the RE systems outright;
- Acceptance of equipment as collateral by suppliers: many commercial banks are unwilling to lend to RE projects because they do not consider the RE equipment acceptable collateral against their loans. The primary reason is that they are unsure of the secondary market for the RE equipment. To overcome this barrier, RE equipment suppliers are beginning to indicate their willingness to repurchase their equipment at a prescribed discount in the event the project fails financially. In these cases, commercial banks are more willing to accept RE equipment as collateral when financing RE projects;
- Support for project preparation/development: one of the principal barriers identified for RE projects is the high project-development-costs-to-investment ratio. In recognition of this fact, a number of multilateral, bilateral and national sources have established funds or programmes to help RE project developers overcome these high development costs. These are specifically technical assistance grants that, in some cases, are repayable when the project reaches financial closure. The eligibility and conditions for project preparation assistance vary considerably according to the objectives of the supplier of the funds;
- Financial bundling: to achieve critical mass in the request for financing and to reduce the transaction costs of small financial assistance requests, a number of small-scale RE projects may be bundled into one single financing package for submission to the financial institution. This financing technique allows small RE projects to access large financial institutions.

#### **IV. Economic, legal, policy and regulatory issues**

17. An array of fiscal incentives, market mechanisms and regulatory instruments are available to encourage a faster uptake of sustainable energy in the power supply mix. A selected set of economic incentives and policy instruments that are available are briefly discussed below.

##### **Economic incentives and market mechanisms**

###### **Investment tax credits**

18. A tax credit is provided based on the investment cost of the project.

###### **Production tax credits**

19. This type of credit provides the investor or owner of qualifying property with an annual tax credit based on the amount of electricity generated by that facility. By focusing on production, improved project performance is encouraged.

###### **Property tax reductions**

20. Reductions in property taxes can be used to promote development of renewable energy projects, especially wind energy, by decreasing the tax burden associated with owning a wind power facility. The tax burden for wind power projects is higher compared with that for the use of fossil energy, since a greater land area of land is required per kilowatt hour (kWh) of output. The disadvantage of this mechanism is that it produces an incentive for development, not a market per se.

###### **Accelerated depreciation**

21. Tax depreciation is a non-cash expense meant to approximate the loss of asset value over time. It is defined as the portion of an investment that can be deducted from taxable income in any given year. Accelerated depreciation results in tax benefits early in a project's life, and is preferred by investors because an after-tax dollar is worth more today than in later years.

###### **Direct production incentives**

22. Although similar to a production tax credit, direct production incentives provide cash income directly. The United States Government offers 1.5 cents per kWh in production incentive to non-profit organizations that own wind facilities.

###### **Investment assistance**

23. Governments can offer soft loans with average interest rates of 1 to 2 per cent below the rates in the capital market. Rates are fixed for the duration of the loan and thus provide easier financing for renewable energy technologies.

###### **"Long-term avoided cost standard offer contracts" for small and distributed projects**

24. During the 1980s, long-term standard offer contracts (the so-called Standard offer 4 contracts) that guaranteed energy and capacity payments 10 years into the future (and saved on transaction costs) were pivotal in the development of the wind electric and solar thermal electric industries in California. Owing to the contracts, over 1,000 electrical MW (MWe) of wind generation capacity and over 400 MWe of solar thermal electric power generation capacity were developed commercially. The guaranteed prices were based on each utility's "full avoided cost" of marginal generation assuming continuously escalating energy prices (which did not materialize). As these contracts have been renewed, the new prices have been much lower and threaten the viability of operating systems.

##### **Policy and regulatory instruments**

###### **Denmark: Windmill law**

25. This law requires electric utilities to purchase output from private wind turbine owners at 85 per cent of the consumer price of electricity plus ecotax relief, or about kroner 0.62, or 9 cents per kWh. Electric utilities receive kroner 0.10 or 1.5 cents per kWh production subsidy for power generated by wind.

###### **Denmark: Energy 21**

26. In earlier years, Denmark undertook development of wind energy to lessen dependence on imported oil. Now development is tied to its Energy 21 goal of reducing carbon dioxide (CO<sub>2</sub>) emissions by 20

per cent by 2005. This translates into an initial 1,500 MW of wind capacity on land and later, by 2030, 4,000 MW offshore. This plan also encourages support at the grass-roots level as local planning boards have been asked to include wind in their energy plans.

#### **Germany: Electricity feed law (EFL)**

27. Since 1991, the Electricity feed law (EFL) has obliged electric utilities to purchase renewable energy at guaranteed prices equal to 90 per cent of retail price. As an example, for wind energy, this amounts to deutsche mark (DM) 0.1715, or 10.5 cents per kWh in 1997 for the life of the plant — a significant stimulus to development. In the future, as prices come down in Europe's more competitive, liberalized electricity market, the guaranteed price is expected to be lower — about 2 per cent less in 1998. This type of decrease is expected to gradually put economic pressure on developers. In addition, the electric utilities are opposed to the EFL because of the burden it places on them.

#### **Germany: 250 Megawatt programme**

28. The goal of the 250 Megawatt programme is to carry out a broad test over several years of the application of wind energy on a commercial scale. As an incentive for their participation in the programme, operators of the wind turbine/wind farm receive grants for the successful operation of their facilities. The current benefit is either DM 0.06 or 0.08 (about \$0.03 or \$0.04) per kWh depending on whether the energy is fed into the grid or used by the owner of the turbine, respectively.

#### **Renewable energy set-asides**

29. In California, a recent ruling provides for a 0.7 per cent surcharge on electric bills to support renewables during the four-year transition to a competitive market. Some 300 MW of new wind energy projects won the opportunity to receive California Energy Commission financial incentive funds.

#### **Net metering or net billing**

30. Under this system, utility customers are guaranteed a market for their power by being permitted to operate a "reversible meter". When customers use more electricity than they generate, they pay for the

additional electricity at retail prices as usual. Conversely, when customers generate more electricity than they use, the electric utility is obliged to purchase the additional electricity. The price that customers receive for their excess electricity varies widely by region and between wholesale and retail levels. So far, experience in net metering is limited.

## **V. Multilateral financing mechanisms**

31. There are a number of multilateral, bilateral and private sector programmes that are available or emerging that will help support sustainable energy projects. Specifically, the MDBs are aware of and are taking action to direct their energy sector investments towards more sustainable development. For example, the World Bank has established the Asia Alternative Energy Programme (ASTAE) which is chartered to develop only RE and energy efficiency projects. Since its inception, ASTAE has helped the World Bank lend over US\$ 250 million for RE projects in the Asia region. IFC has launched two solar PV initiatives — the Solar Development Group and the Photovoltaic Market Transformation Initiative (PVMTI) — focused on private sector-initiated projects.

### **Economic instruments for promotion of investments**

32. Three multilateral economic instruments are highlighted to illustrate the mechanisms that are being utilized by the different multilateral organizations in promoting sustainable energy investments.

#### **FINESSE (Financing Energy Services for Small-Scale End-users)**

33. Financing Energy Services for Small-Scale End-users (FINESSE) focuses on the formulation of policy, institutional/regulatory framework and capacity development to provide technically feasible and economically viable RE technologies and energy efficiency services to residential, commercial, agro-industrial, and institutional energy users in developing countries. The FINESSE concept resulted from the recognition that traditional energy sector lending by multilateral and bilateral institutions was biased towards large-scale fossil and hydro-based projects. This narrow focus of the traditional energy sector on

supply-driven large-scale projects ignored the basic energy needs of the majority of people residing in rural communities and did not properly address the energy efficiency improvement potential of residential, commercial and industrial sectors. The FINESSE concept was initiated in 1989 jointly by the World Bank, the United States Department of Energy (USDOE), the Netherlands Directorate for International Cooperation (DGIS) and UNDP.

34. The FINESSE concept is both an operational research methodology and an energy development approach. Central to the concept is the need to mitigate recognized barriers to the development and widespread use of sustainable energy services. It is a piloting activity that aims at making financial resources of multilateral lending institutions available to small-scale energy users who often have no means of accessing credit. Large multilateral financing institutions are encouraged to provide "wholesale" loans to intermediary organizations such as commercial banks, utilities and non-governmental organizations. Through the implementation of the FINESSE concept, the multilateral financing institutions are able to provide financial resources to small-scale energy users without incurring high overhead costs in administering small loans. The intermediary organization then provides loans at market rates to the potential small-scale energy end-users.

35. Currently, FINESSE is operational in selected countries in Asia and Africa. The FINESSE concept is implemented by UNDP with support from DGIS, and the Organization of the Petroleum Exporting Countries (OPEC) Fund for International Development.

#### **The United Nations Foundation (UNF)**

36. The goals and objectives of the United Nations Foundation (UNF) are to support the work of the United Nations in economic, social, environmental and humanitarian causes. One of two primary environmental issues that UNF addresses is the concern associated with global climate change, the other environmental issue being loss of biological diversity. In the climate change area, the Foundation assists in the implementation of relevant agendas that result from the continued work of the United Nations Framework Convention on Climate Change. The Foundation primarily supports activities on the use of market mechanisms and sustainable energy technologies to meet the objectives of the Framework Convention.

37. In carrying out its mandate to address global climate change, the UNF provides resources for projects in the areas of human capacity-building, energy efficiency, RE, technological leapfrogging, and the design of economic and regulatory frameworks. Only United Nations agencies can apply for support directly to the Foundation. Furthermore, UNF encourages collaboration between two or more agencies of the United Nations when support is applied for.

#### **World Bank Asia Alternative Energy Programme (ASTAE)**

38. The World Bank, along with key bilateral donors, established the Asia Alternative Energy Programme (ASTAE) in January 1992, as a follow up to project FINESSE. ASTAE's mission is to mainstream alternative energy (RE and energy efficiency) services in the energy and non-energy lending operations of the World Bank, with priority emphasis on the Asia region. To support this goal, ASTAE works with both Bank staff and client country decision makers to incorporate alternative energy options into the design of energy sector strategies and lending operations for all the Bank's client countries in Asia. Since its inception, ASTAE has increased the lending portfolio for alternative energy projects in Asia from about US\$ 2.0 million in fiscal year 1992 to over US\$ 1 billion (fiscal years 1993-2003). These investments are projected to result in over 1 gigawatts (GW) of avoided fossil fuel-based capacity through RE capacity additions and energy efficiency demand reductions.

39. ASTAE provides assistance in the identification and preparation of RE and energy efficiency/demand-side management (DSM) projects for World Bank- and GEF-supported operations in Asia. ASTAE also offers technical assistance in improving local technical expertise, system performance, and institutional capability to design and implement alternative energy investment programmes in the client countries. Such activities have included: training modules in energy efficiency and RE options; formulation of alternative energy policies; design and implementation of pilot innovative delivery mechanisms; technical support to improve the performance and availability of alternative energy systems; and strengthening of institutional capacities. In addition to increasing the RE and energy efficiency portfolio in power sector lending, ASTAE is

also working to increase the inclusion of alternative energy services components in non-energy sector lending.

### **Existing financing mechanisms**

40. The primary multilateral financing mechanisms that are currently under operation are briefly summarized in the present section.

#### **Solar Development Group (SDG)**

41. The World Bank, IFC and a group of United States charitable foundations initiated the Solar Development Group (SDG) with the overall objective of accelerating the growth of viable private-sector business activities in the distribution, sales and financing of off-grid PV applications in developing countries. The capitalization of SDG is US\$ 50 million for investment in SHS deployed on rural houses. SDG, acting as a privately managed fund, will invest in PV-related businesses including local assemblers, distributors, retailers and energy service companies as well as in financial intermediaries such as banks, leasing companies, non-governmental organizations and other non-bank financial intermediaries. Approximately US\$ 32 million will be earmarked as an investment fund, while US\$ 18 million will be used to support in-country business advisory services (BAS). The investment fund will provide debt and equity capital. BAS will provide technical assistance to potential businesses and companies. SDG activities are being initiated and the pilot project will operate for five to eight years.

42. SDG aims to overcome the key barriers to accelerated growth of PV in the off-grid segment — including lack of medium-term funding to enable customers to repay the high initial cost of PV systems over time, lack of understanding of PV by conventional financial intermediaries (FIs) and weak capitalization of many indigenous PV companies — through the provision of both financing and business advisory services. To achieve these aims, SDG will: (a) invest in private sector companies involved in rural commercially sustainable PV activities, including the distribution, sale, lease-hire, or financing of PV solar home systems and other productive use PV systems for electricity generation and (b) provide financing to local FIs that will service such companies.

#### **Global Environment Facility (GEF)**

43. GEF is a financial mechanism of international environmental agreements including the United Nations Framework Convention on Climate Change. The three implementing agencies of GEF are UNDP, the United Nations Environment Programme (UNEP) and the World Bank. GEF resources are used to support the incremental cost of environmentally beneficial projects relative to the cost of the baseline project. GEF provides grants and concessional finance for project development activities, enabling activities and full projects. Projects supported by GEF must be country-driven and based on national development priorities.

44. The three operational programmes of GEF that focus on climate change mitigation and sustainable energy technologies are:

- Operational Programme (OP) 5: Removing barriers to energy efficiency and energy conservation;
- OP 6: Promoting the adoption of RE by removing the barriers and reducing implementation costs;
- OP 7: Reducing the long-term costs of low greenhouse gas-emitting energy technologies.

45. The Enabling Activities are specifically designed to assist non-annex I countries (primarily developing countries) in meeting their communications obligations and the overall objectives of the Framework Convention. Projects that do not qualify under the “long-term operational programmes” or the Enabling Activities but are high national priority and are cost-effective may be considered under the Short-term Response Measures.

46. GEF also administers the Small Grants Programme (SGP) that provides grants up to US\$ 50,000 for projects that are designed and implemented by local community organizations and non-governmental organizations and that meet the objectives of GEF. SGP is implemented by UNDP. The types of activities eligible for SGP include community-based demonstration programmes, pre-project community-based assessment and planning activities, targeted research with emphasis on indigenous knowledge and management systems, and information dissemination, networking and policy dialogue.

### **Photovoltaic Market Transformation Initiative (PVMTI)**

47. The aim of PVMTI is to accelerate the commercialization of the PV market in three countries (India, Morocco and Kenya). GEF has committed US\$ 30 million to the Initiative and it is expected that the private sector, possibly IFC and/or other co-financing investments will leverage an additional three to four times the GEF committed amount. PVMTI began operation in June 1998 and will operate for 10 years. IFC is the executing agency of PVMTI.

48. PVMTI was initiated with the premise that the potential for the off-grid PV market is very large, since 300 million to 400 million households in developing countries lack access to dependable power. The types of projects envisaged are SHS in the 20-500 peak-watt ( $W_p$ ) range and small power plants serving commercial end-users, municipalities and villages, in the 50 kW to 5 MW range that may also use hybrid technologies (solar systems backed by wind or diesel/gas generators).

49. PVMTI will provide investments in the range of US\$ 0.5 million to US\$ 5.0 million per project that shows promise for large-scale expansion of the market for PV. The PVMTI support will be provided in the form of grants or various non-grant-financing modalities. However, in Morocco and Kenya, the projects need to leverage additional minimum resources 1:1, while in India the project developers need to leverage three times the PVMTI resource. The expected outcomes of the Initiative are increased market activity, reduced market barriers to PV dissemination and successful demonstration of private-sector-based financing schemes. PVMTI investments will be managed by an external team specializing in RE financing and technical and programme oversight under close supervision by IFC.

### **Proposed financing mechanisms**

50. Two of the proposed financing mechanisms for sustainable energy development have as their primary objective the reduction of greenhouse gas emissions in support of the Framework Convention. One of the mechanisms is entirely a private sector initiative while the last mechanism is a regional instrument initiated by the World Bank to expand energy access in rural areas of Africa.

### **Clean Development Mechanism (CDM)**

51. Article 12 of the Kyoto Protocol<sup>2</sup> to the Framework Convention established the clean development mechanism (CDM). The purpose of CDM is to assist non-annex I parties to the Framework Convention in achieving sustainable development and to assist annex I parties in achieving compliance with their emission limitations or reduction commitments under the Kyoto Protocol. CDM is one of three flexibility mechanisms of the Kyoto Protocol. The rules and modalities for CDM are still currently under negotiation by parties to the Framework Convention. It is envisaged that when CDM becomes operational, Governments and private enterprises in the industrialized countries (annex I parties) will invest in projects in developing countries that reduce greenhouse gas emissions with respect to baseline projects. Sustainable energy projects will form a significant portion of these CDM projects. Under the rules of CDM that may be agreed upon in the future, the certified carbon emission reductions that occurred owing to the alternative/CDM project can be transferred to the project supporter in the developed country.

52. CDM can significantly stimulate the development and implementation of low carbon emitting energy projects as well as RE and energy efficiency activities. The implementation of sustainable energy/greenhouse gas (GHG) mitigation projects in developing countries may also result in significant transfer of technology. Furthermore, the provision of better energy services will improve the living standards in developing countries.

### **Prototype Carbon Fund (PCF)**

53. The Prototype Carbon Fund (PCF) is being established in the World Bank with contributions from Governments and private companies. PCF will invest in cleaner technologies in developing countries and transition economies, primarily in RE technologies such as wind, small hydro, and biomass energy technology. The independently verified and certified emissions reduction credits that result from the cleaner technologies will be transferred to the Fund's contributors. The Fund is capped at US\$ 150 million, and will start operations soon. The Fund is expected to terminate at the end of 2012.

54. During the next three years, PCF plans to invest all the capital in about 20 projects that have mostly been identified by the World Bank group, but projects can also originate from the private sector, other multilateral development banks or bilateral donors. In some cases, PCF plans to finance some projects through local carbon funds modelled on PCF but using financing from local commercial and development banks, as well as private companies.

55. Developing countries are expected to benefit from the projects that are supported by investment funds from PCF, since cleaner technologies will be installed in the countries. Industrialized countries and private companies will also gain since they will be able to obtain certified carbon emissions reduction credits at a lower price than from reducing carbon emissions within their own companies or countries. PCF plans to incorporate any agreements and rules that may be adopted by parties to the Framework Convention with respect to the Kyoto Protocol and its flexibility mechanisms: joint implementation (JI) and CDM.

#### **Africa Rural and Renewable Energy Initiative (AFRREI)**

56. The objective of the Africa Rural and Renewable Energy Initiative (AFRREI) is to expand energy access in rural areas of Africa where rural population is increasing faster than rural access to modern energy. AFRREI will also promote synergistic activities to facilitate rural transformation of communities, businesses and rural households, using RE where appropriate. Providing energy access for rural areas in Africa is especially difficult, since rural populations are scattered, and have small power needs and low, irregular incomes, and public utilities are not effective in providing energy services.

57. The Initiative will (a) demonstrate the potential of combining new technology and financing with partnerships of local private sector and communities and (b) promote region-wide, community-based sustainable management of traditional fuels (policy and investments). AFRREI's strategy focuses on four main components. They are described below:

(a) There is to be systematic facilitation of private sector-led, commercially based service delivery to under-served "rural" areas emphasizing:

(i) A demand-driven approach that encourages and builds on local institutions;

(ii) Multiple supply options and delivery systems;

(iii) A long-term view of starting small and looking to grow big, building in flexibility;

(b) The key driver of the initiative will not be access alone but rural transformation, attention being given to non-farm generation and community needs;

(c) A balance must be achieved between affordability and sustainability while scaling up, incorporating very low cost designs and "smart subsidies";

(d) The Government must have the role of a market enabler, not a service provider.

58. The initiative aims to provide grants for capacity-building and loans for rural electrification programmes. AFRREI will initially focus on four countries in Africa — Mozambique, Uganda, South Africa and Zimbabwe.

#### **Shell Foundation Sustainable Energy Programme (SEP)**

59. The Sustainable Energy Programme (SEP) of the Shell Foundation, established by Shell International, will provide grants for projects that reduce the environmental impact of continued fossil fuel use or increase the access of poor communities in developing countries to improved energy sources and services. Under the broad category of Reducing impacts from fossil fuel use, SEP will support projects that address sustainable transport, climate change through market-based mechanisms for limiting greenhouse gas emissions, and the reduction of environmental impacts from conventional electricity generation. Under the category of Increasing access for the poor to better energy services, SEP will develop and support projects that:

(a) Encourage local businesses to find new ways to supply cleaner energy and improved energy services to poor people;

(b) Link the use of improved energy services to improving the ability of poor people to earn greater incomes;

(c) Improve the "enabling environment" necessary for markets to operate in ways that reduce energy poverty.

60. The types of projects that will be supported by SEP are research and analysis, technical assistance, education, training, conferences, study tours, pilot and demonstration projects. SEP will provide funding only for projects that are undertaken by non-governmental organizations and other non-profit groups working in the public interest. The Programme will fund up to US\$ 17 million in the first three years with a target of US\$ 22 million per year within 10 years.

assistance in obtaining loans from the World Bank, the Asian Development Bank, and DANIDA for wind power development.

#### *Notes*

<sup>1</sup> A/AC.237/18 (Part II)/Add.1 and Corr.1, annex I.

<sup>2</sup> FCCC/CP/1997/7/Add.1, decision 1/CP.3, annex.

### **Role of national Governments**

61. In promoting sustainable energy development, national Governments can play a catalytic role by providing institutional and technical support, market-enabling policy and fiscal incentives, and facilitating the availability of financial resources. A brief summary of India's wind power programme is presented to illustrate the use of fiscal incentive mechanisms, policy measures, and the leveraging of international concessional finance to accelerate the development of wind power in India.

62. At the present time, there is approximately 1,000 MW of installed wind power, primarily in the States of Tamil Nadu and Gujarat, in India. The Tamil Nadu State Electricity Board (SEB) and several other SEBs have agreed to purchase wind power at the equivalent of about US\$ 0.064 per kWh. The Indian Government also supports a large wind assessment programme with over 600 stations in 25 States to provide information regarding the best wind sites for development. Furthermore, India offers the following tax incentives to increase wind power development:

- Five-year tax holiday on income from sales of electricity;
- First-year 100 per cent depreciation on investments in capital equipment for wind electric power generation and other RE investments;
- Excise duty and sales tax exemptions for wind turbines;
- Waiver of import duties on a variety of components.

63. India is currently considering switching from investment tax benefits to production tax incentives to increase the performance of the deployed wind power projects. Lastly, India Renewable Energy Development Agency (IREDA), established in 1987, provides

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**The multi-purpose use of hydro resources**

**Status of hydroelectricity generation****Report of the Secretary-General****Contents**

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\* E/C.14/2000/5.



**Abbreviations and symbols used**

|                            |                                                                                                                                                                     |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO<sub>2</sub></b>      | carbon dioxide                                                                                                                                                      |
| <b>GHG</b>                 | greenhouse gas                                                                                                                                                      |
| <b>GW</b>                  | gigawatt                                                                                                                                                            |
| <b>kWh</b>                 | kilowatt-hour                                                                                                                                                       |
| <b>MW</b>                  | megawatt                                                                                                                                                            |
| <b>non-OECD<br/>Europe</b> | Eastern Europe and the former Soviet Union (the present text specifies whenever the Central Asian republics are considered separately from this group of countries) |
| <b>OECD</b>                | Organisation for Economic Cooperation and Development                                                                                                               |
| <b>TWh</b>                 | terawatt-hour                                                                                                                                                       |
| <b>%</b>                   | per cent                                                                                                                                                            |

## Introduction

1. Electricity accounts for an increasing share of final energy demand worldwide and this trend is set to continue, especially in developing countries. Although fossil fuels have continued to be the dominant primary energy source for electricity generation worldwide, hydropower has made tangible progress in many countries. Being an indigenous resource and because of its large potential, hydropower can be expected to contribute significantly to electricity generation in a large number of countries in the developing world, especially in Africa and Asia.
2. Almost without exception, electricity demand in developing countries has been rising rapidly and there is an ever-widening gap between supply and demand. Electricity has increasingly assumed greater importance in the total energy mix of developing countries, as adequate and reliable electric power is central to economic and social development.
3. Hydroelectric power may have reached a mature state of development in most Organisation for Economic Cooperation and Development (OECD) countries (see figure I for net exploitable hydropower resources and percentage exploited), while in the developing world there remains a huge potential for further development. However, concerns about environmental impacts and land requirements for reservoirs have recently constrained multilateral assistance in hydropower development in developing countries. This should be examined in the context of the current discussions on carbon emissions and global warming, giving careful consideration to both developmental needs and environmental and social concerns. Hydropower, large-, mini- and micro-scale, is a time-tested source of electricity generation that is relatively free of greenhouse gas (GHG) emissions. In ecological terms, hydroelectricity has many advantages at a time when considerable efforts must be made to reduce GHG emissions.
4. Electric power generation has become the focal point of determined national economic development programmes aimed at accelerating economic growth and social development. Long-term growth in electricity consumption is expected to remain strong in the developing economies mainly as an outgrowth of improving the quality of life of people: rising per capita income levels and increasing use of electricity are unequivocally linked.

**Figure 1**  
**Extent of development of world hydropower resources**

**Net exploitable in terawatt-hours per year (TWh/yr) and percentage exploited**

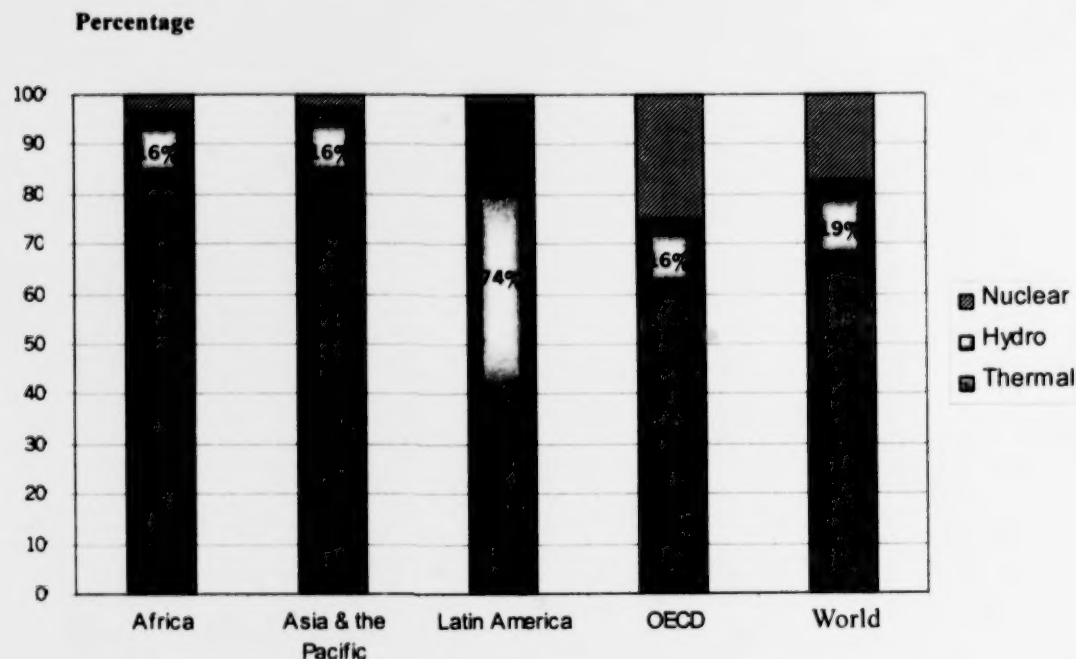


Source: Department of Economic and Social Affairs of the United Nations Secretariat, based on *Energy Statistics Yearbook, 1996* (United Nations publication, Sales No. E/F.99.XVII.3); and *Renewable Energy Resources: Opportunities and Constraints, 1990-2020*, (London, World Energy Council, September 1993).

## I. Hydroelectricity generation

5. World installed electric generating capacity stood at about 3,118 million kilowatts (kW) in 1996; and of the world net installed electric generating plants, power plants that use fossil fuels dominate with a share of about 65.2 per cent followed by hydro with a share of about 22.6 per cent, nuclear with a share of 11.2 per cent and other sources (geothermal, wind, solar and biomass) with a share of about 1 per cent. Figure II shows the share of electricity generation by the three major types: in 1996, hydroelectricity generation accounted for about 16 per cent of the total electricity generated in Africa, Asia and the Pacific and OECD countries, while in Latin America the bulk of electricity generation was by hydropower, accounting for about 74 per cent of the total electricity generated.<sup>1</sup>

**Figure II**  
**Share of electricity generation by major type in 1996**

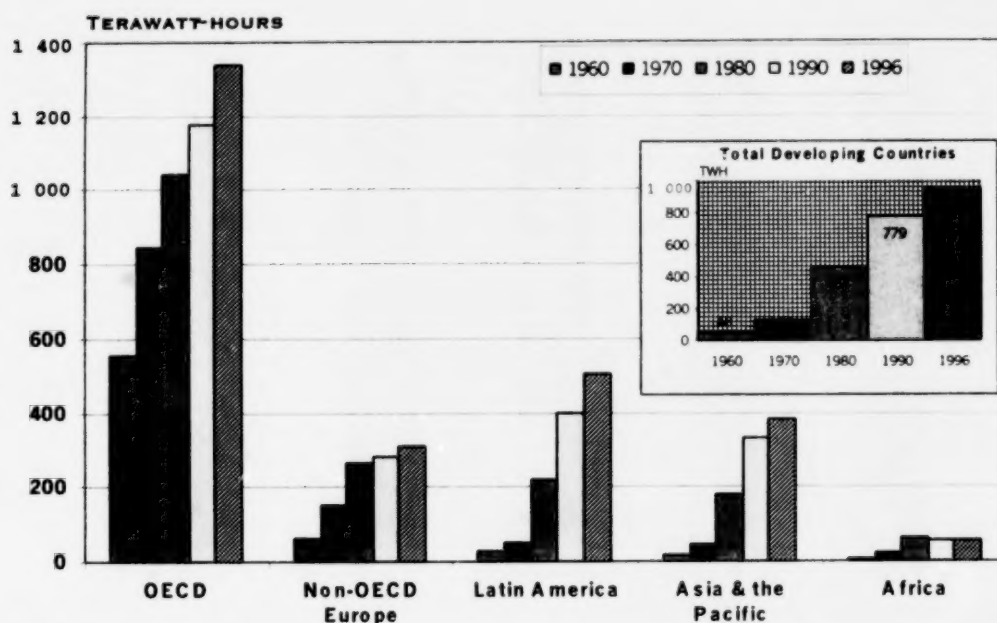


Source: Department of Economic and Social Affairs of the United Nations Secretariat, based on *Energy Statistics Yearbook* (United Nations publication), various issues.

6. Worldwide, the generation of hydroelectricity increased from 2,041,448 million kilowatt-hours (kWh) in 1987 to 2,588,324 million kWh in 1996, an increase of 546,876 million in the 10-year period, for an average annual gain of about 2.3 per cent.<sup>2</sup> The United States Energy Information Agency's International Energy Outlook, 2000, projects an increase in hydroelectricity consumption of 54 per cent between 1997 and 2020, just enough to maintain the hydroelectricity and other renewable sources of energy share at about 8 per cent of the total world energy consumption. Almost half of the increase is expected in the developing world where large-scale hydroelectric projects are being planned and constructed.

7. Total hydroelectricity generation in the different regions between 1960 and 1996 can be seen in figure III. OECD countries were by far the largest producers of hydroelectricity with a total of about 1,337,825 million kWh (about 1,338 terawatt-hours (TWh)) in 1996, while the rest of the world registered hydroelectric power production of about 1,250,499 million kWh. The insert in the chart illustrates the comparatively low level of total hydroelectricity generation in all developing countries — about 944,186 million kWh (approximately 944 TWh), or 70 per cent of total hydroelectricity generation of the OECD countries in 1996.<sup>2</sup>

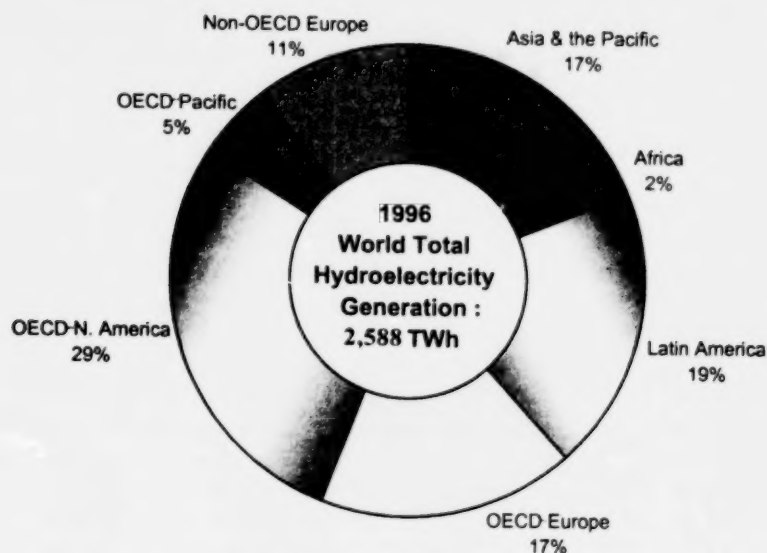
**Figure III**  
**Hydroelectricity generation by region, 1960-1996**



Source: Department of Economic and Social Affairs of the United Nations Secretariat, based on *Energy Statistics Yearbook* (United Nations publication), various issues.

8. In 1996, OECD-North America countries were the largest producers of hydroelectricity with a total production of about 728,828 million kWh, constituting a 29 per cent share of the world total hydroelectricity generation, followed by Latin America with about 502,222 million kWh, constituting a 19 per cent share. OECD-Europe and the Asia and the Pacific countries accounted for about a 17 per cent share each of the world total hydroelectricity generation. Other regional shares were: non-OECD Europe, 11 per cent; OECD-Pacific, 5 per cent; and Africa, 2 per cent (see figure IV and table). Canada, the United States of America, Brazil, China and the Russian Federation were the five largest producers of hydroelectric power in 1996. Their combined hydroelectricity generation accounted for more than half of the world total.<sup>1</sup>

**Figure IV**  
**Regional shares of hydroelectricity generation in 1996**



*Source:* Department of Economic and Social Affairs of the United Nations Secretariat, based on *Energy Statistics Yearbook, 1996* (United Nations publication, Sales No. E/F.99.XVII.3).

**Regional hydroelectricity generation, 1996**  
(Millions of kilowatt-hours)

|                      |           |
|----------------------|-----------|
| World                | 2 588 324 |
| Asia and the Pacific | 433 347   |
| Africa               | 58 779    |
| Latin America        | 502 222   |
| OECD-Europe          | 452 466   |
| OECD-North America   | 728 828   |
| OECD-Pacific         | 136 054   |
| Non-OECD Europe      | 276 628   |

*Source:* Department of Economic and Social Affairs of the United Nations Secretariat, based on *Energy Statistics Yearbook, 1996* (United Nations publication, Sales No. E/F.99.XVII.3).

## II. Hydroelectricity developments: developing world

9. Many hydropower projects are under way or are being planned for construction in several countries of the developing world. The more significant hydroelectricity projects in the different regions of the developing world are highlighted below. Apparently, the development of those hydroelectric facilities would contribute significantly towards sustaining the growth of renewable energy in the foreseeable future.

### A. Asia and the Pacific

10. Asia's water resources constitute a vast potential, both for generating hydroelectricity and for irrigation. Several major river systems have excellent hydroelectric potential, and lend themselves to construction of dams with low heads and great volumes of flow. However, seasonal variation in precipitation is a critical factor in developing most of those sites. Hydrologic flows well below anticipated levels for extended periods as a result of drought will lead to severe drops in hydropower output, causing major uncertainty in revenues from hydropower.

11. Several hydroelectric projects are currently under way in the region: China, India, the Lao People's Democratic Republic, Malaysia and Viet Nam all have plans to add large hydroelectricity facilities in the next decade or so. In China, this would amount to over 30 gigawatts (GW) of installed generating capacity. Construction on the 18.2 GW Three Gorges Dam is in its second phase at the end of which the dam will start generating electricity. Upon completion in 2009, the dam is expected to produce as much as 85,000 million kWh of electricity per year. China has announced plans to develop 12 major hydroelectric bases in the country.<sup>3</sup>

12. In India, hydropower constitutes almost 22 per cent (21,104 megawatts (MW)) out of 96,803 MW in 1996) of the total installed electricity generation capacity.<sup>1</sup> There are plans to increase hydroelectric capacity substantially in the next few years — by about 35.5 GW by 2012. Twelve large-scale projects adding up to 4,000 MW of installed capacity are apparently under way and scheduled for completion a few years hence. India is facing serious power supply problems with current generation estimated at about 30 per cent below demand. As a consequence, India is faced with the need to invest heavily in new electric generating capacity. India has forecast that total additions of 111,500 MW will be needed by 2007.<sup>4</sup>

13. Several hydroelectric projects have also been introduced in other countries of the region. In Viet Nam, hydroelectricity currently accounts for about 60 per cent of the country's total electricity generating capacity of about 5,000 MW and construction of a 3,600 MW hydropower plant to be operational in a decade or so is being planned. Malaysia has resurrected plans for a large-scale hydroelectric project in Sarawak, although the project has been scaled down to 500 MW of generating capacity. Thailand has reached agreement with the Lao People's Democratic Republic to purchase additional electricity from hydropower stations in the Lao People's Democratic Republic.<sup>5</sup>

14. The potential hydroelectric resource of Nepal has been estimated as being as high as 83,000 MW, although less than 1 per cent has been developed. A 144 MW hydropower project is under way with financing from the Asian Development Bank and the Japanese Government; and India and Nepal have reached an agreement for

joint development of hydroelectric projects, as India is a prime potential market.<sup>6</sup> India will also be developing a number of hydroelectric projects in Bhutan within the next decade so as to be able to import electricity into several Indian States on the country's eastern grid. Sri Lanka is almost totally reliant on hydropower for its electricity, making it vulnerable to fluctuations in rainfall.<sup>5</sup>

15. In the Islamic Republic of Iran, it is estimated that some 6,000 MW of new hydroelectric capacity could be installed by 2020.<sup>5</sup>

## **B. Africa**

16. In many African countries, the hydroelectricity share of installed electricity generating capacity is quite high and is projected to double in the next two decades: in the Democratic Republic of the Congo, Côte d'Ivoire, Ethiopia, Mozambique and Zambia, virtually all grid-connected electricity generation comes from hydroelectricity.<sup>7</sup>

17. In East Africa, Ethiopia has plans to significantly increase the country's electricity-generating capacity. A 34 MW hydroelectric plant in western Ethiopia has been completed, while other existing facilities are being upgraded. Under construction are 184 MW and 73 MW hydroelectric facilities; a 150 MW hydroelectric facility on the Gojeb river is expected to become operational by 2003 and additional hydroelectric facilities are planned. In the northern Sudan, a 300 MW hydroelectric power plant located on the Nile is planned and adequate financing for it has apparently been secured. In southern Uganda, on the Nile, the 180 MW Owens Falls hydroelectric facility is being expanded to include an additional 200 MW of generating capacity. Another 250 MW facility on the Nile could become operational by 2002 and will be the largest of several hydroelectric independent power producer (IPP) projects currently being developed in Uganda. A 180 MW hydroelectric project is being planned in north-western Uganda as well as a smaller facility of 10-12 MW.<sup>7</sup>

18. In Southern Africa, Angola's generation capacity will nearly double when the 520 MW Capanda hydroelectric facility is completed. The Lesotho Highlands Water Project, which involves the construction of dams, tunnels and pipelines, is designed to include a total of 274 MW of hydroelectric generating capacity, and an 80 MW hydro facility as a first phase is already in operation. Zambia plans to rehabilitate the generation facilities at Victoria Falls and expects to restore the facility to its full generating capacity of 108 MW.<sup>7</sup>

19. In West Africa, Ghana has plans for an additional hydroelectric facility to be located on the Black Volta River and the facility will have a generating capacity of 400 MW and possibly provide power exports to Burkina Faso, Côte d'Ivoire and Mali. The 75 MW Garafi hydroelectric facility was inaugurated in Guinea in July 1999. It is the country's largest hydroelectric facility and will supply power to Conakry, Guinea's capital. Plans for a larger (900 MW) facility downstream of Garafi on the Konkoure River are being discussed.<sup>7</sup>

20. In Central Africa, the Democratic Republic of the Congo plans to further expand the Inga hydroelectric facility located on the Congo River. The 2,000 MW Inga II plant and the 40,000-MW Grand Inga facility are intended primarily for power exports to Southern Africa. The combined capacity of these two projects is

nearly as large as South Africa's current installed capacity. Other interconnections are currently under way or planned. The Angola-Namibia Kunene River hydroelectric project will consist of a 200-380 MW generating facility that supplies power to Angola, Namibia and South Africa.<sup>7</sup>

21. In North Africa, in Egypt, hydroelectricity from three hydro plants on the Aswan account for about 51 per cent of the country's total electricity generating capacity. However, very little growth in installed hydroelectric capacity is expected in the next few years in Egypt.<sup>8</sup>

### **C. Latin America**

22. In Central and South America, primarily in Brazil, Chile, Colombia, Paraguay, Peru and Venezuela, hydroelectric dams account for 50 per cent or more of the total installed generating capacity, and there are plans to add substantial capacity in several countries of the region. In Argentina, hydropower accounted for about 43 per cent of installed electricity generating capacity.<sup>9</sup>

23. In Chile, hydropower from westward-flowing rivers from the Andes Mountains is its largest electricity source, constituting about 80 per cent of installed electricity generation capacity. The major drought from late 1997 until well into 1999 severely impacted on the country's electricity sector, during which time rolling blackouts were in effect in Santiago, the capital city. As a result, Chile is now working to diversify its primary energy sources for electricity generation.<sup>9</sup>

24. Brazil's main source of electricity comes from hydropower, providing roughly 95 per cent of the country's electrical energy. Along with Paraguay, Brazil maintains the world's largest hydro complex, the Itaipu facility, with a capacity of 12,000 MW.<sup>9</sup>

## **III. Small-scale hydropower**

25. Almost all developing countries are under political and social pressure to supply electricity to scattered rural areas. Rural electricity supply is often constrained by low population densities and the very low purchasing power of rural people, which limit the choice of commercially viable decentralized supply options. In respect of the consideration of the lowest cost of providing electricity to rural areas, decentralized mini- and micro-hydro plants can be an attractive option for integrating rural areas into a "local grid" system.

26. Mini-hydropower, with capacities between 0.5 and 2 MW, is an increasingly attractive means of generating primary electricity, using the water resources of small rivers, particularly in areas remote from the national grid. Mini-hydropower is a well-developed technology, aided by new design techniques, and is appropriate for both developed and developing countries.

27. The United Nations has completed a survey to evaluate mini-hydropower resources in 46 developing nations, the objective of which was to identify technically feasible and economically attractive projects for supplying electricity to isolated areas. The results of the survey indicate the vast scope for this technology in many regions, and follow-up projects at some sites have demonstrated the need to

take account of the environmental, social and economic dimensions in developing these resources.

28. Micro-hydropower systems consisting of easily built dams on small rivers and streams, using landfill and rocks and connected to micro-turbines and generators with capacities ranging from 1 to 50 kW, can meet the needs of one family or several households. A typical micro-hydroelectricity generating system would be a "stream engine",<sup>10</sup> where water from a stream is channelled into a pipeline so as to gain sufficient head to power the system consisting of a brushless permanent magnet alternator coupled to a rugged bronze turbo wheel and universal nozzles. It can be used for battery-based power systems, with electricity generated at a steady rate and stored in batteries. At sites where sufficient head and flow rates are available, higher voltages can be generated to transmit over longer distances and the voltage stepped down to charge batteries.

#### IV. Conclusions

29. In order to meet the challenges of sustainable development, all technology options for electricity generation should be kept open. Hydro derives its energy from a renewable resource and is therefore, by definition, renewable; and thus renewable hydroelectricity has significant potential to reduce emission of GHGs by substituting for existing and planned fossil fuel fired generation. Expanding the use of hydropower is cost-effective, does not create market distortions and can sharply reduce carbon dioxide (CO<sub>2</sub>) emissions from the electric power sector.

30. Nonetheless, there are environmental drawbacks associated with hydropower, especially as regards the effect of dams on river ecosystems. Environmental degradations, such as ecological changes, effects on fish and reduced water flow, need to be addressed. For large-scale hydropower development, population displacement is conspicuous: careful site selection and project design limiting the maximum reservoir level, for example, may minimize the displacement.

31. Environmental considerations, such as carbon emissions particularly in the case of fossil fuels and habitat destruction in the case of hydroelectric dams, for instance, can complicate the choice of fuels for new power plants. Frequently, financial and social considerations also come into play.

#### Notes

<sup>1</sup> *Energy Statistics Yearbook, 1996* (United Nations publication, Sales No. E/F.99.XVII.3).

<sup>2</sup> *Energy Statistics Yearbook* (United Nations publication), various issues.

<sup>3</sup> Three Gorges Dam, China, web site (<http://www.coxnews.com/washington/gorges.htm>).

<sup>4</sup> South Asia Regional Review, United States Energy Information Agency (EIA), web site (<http://www.eia.doe.gov/>).

<sup>5</sup> United States Energy Information Agency (EIA), *International Energy Outlook 2000*, March 2000, p. 93.

<sup>6</sup> Statement made by the delegation of Nepal at the session of the Ad Hoc Open-Ended Intergovernmental Group of Experts on Energy and Sustainable Development, 6-10 March 2000, New York.

<sup>7</sup> Energy in Africa, EIA web site (<http://www.eia.doe.gov/>).

<sup>8</sup> See *International Energy Outlook 2000* ..., p. 107.

<sup>9</sup> EIA Country Analysis Briefs: Central and South America web site (<http://www.eia.doe.gov/>).

<sup>10</sup> Energy systems and design: innovative micro-hydro systems since 1980, web site (<http://www.microhydropower.com>).

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for Development****Second session**

14-25 August 2000

Item 10 (e) of the provisional agenda\*

**Review of salient trends and issues on energy development and  
use in the context of sustainable development: coordination of  
energy activities within the United Nations system**

**Coordination of energy activities within the  
United Nations system****Report of the Secretary-General****Contents**

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\* E/C.14/2000/1.



## I. Introduction

1. At its first session, in April 1999, at the suggestion of its Sub-Group on Energy, the Committee on Energy and Natural Resources for Development requested the Secretary-General to prepare a report on the coordination of energy activities within the United Nations system for consideration by the Committee at its second session, in 2000.<sup>1</sup> At its substantive session of 1999, the Economic and Social Council approved the provisional agenda and documentation for the second session of the Committee, including the request for a report on coordination of energy activities within the United Nations system. The present report has been prepared in response to that request.

## II. Activities of the United Nations system in the field of energy

2. United Nations entities and agencies provide detailed descriptions of their activities on a periodic basis to the Ad Hoc Inter-Agency Task Force on Energy for coordination purposes, and the present report is based on that information. The table provides a summary of the main areas of activities undertaken by each entity/agency in the field of energy in preparation for the ninth session of the Commission on Sustainable Development, to be held in 2001, at which the themes "Energy/atmosphere" and "Energy/transport" will be considered.

3. A major challenge in the implementation of Agenda 21 is that energy use is necessary for socio-economic development but that its use results in adverse environmental effects. Using energy in a sustainable way, that is, to promote economic and social development at the least cost to the environment, is an integral goal of sustainable development and has been the focus of United Nations activities in the field of energy since the United Nations Conference on Environment and Development (UNCED) in 1992. Activities in the United Nations system addressing energy issues in such areas as energy efficiency, renewable energy technologies, standards and regulations, the rationalization of energy and demand-side management are aimed at encouraging the dissemination and use of more efficient energy technologies and/or conservation in consumption patterns for a more efficient allocation of resources. The internalization of environmental costs associated

with energy use is a goal of many of those activities. The extent and scope of activities undertaken vary with agency/individual entity mandates. Energy issues are incorporated in overall development programmes in those agencies with mandates relating to general economic and social development and are included in projects and programmes aimed at specific goals, such as poverty alleviation, improvement of health and population activities.

4. Most United Nations agencies/entities engaged in activities related to energy undertake specific projects and/or programmes aimed at institution and capacity-building or integrate capacity-building components in larger projects. Often, the training of nationals is incorporated in projects, including those aimed at promoting renewable energy technologies. Technical assistance is undertaken on a regular basis by the regional commissions, the Food and Agriculture Organization of the United Nations (FAO), the International Atomic Energy Agency (IAEA), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the United Nations Industrial Development Organization (UNIDO), the World Bank and the Department of Economic and Social Affairs of the United Nations Secretariat in the form of policy advisory services and field projects. Financing of specific projects is provided by some agencies and the World Bank, while other United Nations agencies/entities assist in securing funding from donors and foundations. Often, donors require cooperation among agencies/entities to ensure integrated projects with no overlapping of activities, which has also encouraged better cooperation within the United Nations system.

5. The areas of emphasis adopted by individual entities are determined by and large by their mandates. The regional commissions, for example, focus on promoting regional cooperation within their respective regions and energy-related activities are undertaken accordingly. Thus, the Economic and Social Commission for Western Asia has facilitated the interconnection of electricity grids in that region, and the Economic Commission for Europe has assisted in identifying investment barriers related to the extension of gas and electricity networks in Europe and Central Asia. Agencies with specific mandates, such as the World Health Organization (WHO) and the United Nations Population Fund (UNFPA), incorporate energy

**Summary of United Nations agency/entity activities in the field of energy**

|                                                             | <i>Energy<br/>efficiency</i> | <i>Renewable<br/>technologies</i> | <i>Standards<br/>and/or<br/>regulations</i> | <i>Capacity-<br/>building/<br/>training</i> | <i>Rationaliza-<br/>tion/demand-<br/>side<br/>management</i> | <i>Technical<br/>assistance</i> | <i>Cooperation<br/>with other<br/>United Nations<br/>agencies/<br/>entities</i> |
|-------------------------------------------------------------|------------------------------|-----------------------------------|---------------------------------------------|---------------------------------------------|--------------------------------------------------------------|---------------------------------|---------------------------------------------------------------------------------|
| Department of<br>Economic and Social<br>Affairs             | X                            | X                                 |                                             | X                                           | X                                                            | X                               | X                                                                               |
| ECE                                                         | X                            |                                   | X                                           | X                                           | X                                                            | X                               | X                                                                               |
| ECLAC                                                       |                              | X                                 |                                             | X                                           | X                                                            | X                               | X                                                                               |
| ESCAP                                                       | X                            | X                                 | X                                           | X                                           | X                                                            | X                               | X                                                                               |
| ESCWA                                                       | X                            | X                                 | X                                           | X                                           |                                                              | X                               | X                                                                               |
| FAO                                                         | X                            | X                                 |                                             | X                                           |                                                              | X                               | X                                                                               |
| GEF                                                         | X                            | X                                 |                                             |                                             | X                                                            |                                 | X                                                                               |
| IAEA                                                        |                              | X                                 | X                                           | X                                           |                                                              | X                               | X                                                                               |
| UNDP                                                        | X                            | X                                 | X                                           | X                                           | X                                                            | X                               | X                                                                               |
| UNEP                                                        | X                            | X                                 |                                             | X                                           | X                                                            | X                               | X                                                                               |
| UNESCO                                                      |                              | X                                 |                                             | X                                           |                                                              | X                               | X                                                                               |
| United Nations<br>Framework Convention<br>on Climate Change |                              |                                   |                                             | X                                           |                                                              |                                 | X                                                                               |
| UNFPA                                                       |                              |                                   |                                             | X                                           |                                                              |                                 | X                                                                               |
| UNIDO                                                       | X                            | X                                 |                                             | X                                           |                                                              | X                               | X                                                                               |
| WHO                                                         | X                            | X                                 |                                             | X                                           |                                                              |                                 | X                                                                               |
| WMO                                                         | X                            | X                                 |                                             | X                                           |                                                              |                                 | X                                                                               |
| World Bank                                                  | X                            | X                                 |                                             |                                             |                                                              | X                               | X                                                                               |

Source: Department of Economic and Social Affairs, "Matrix of activities", accessed at:  
<http://www.un.org/esa/sustdev/iaenr.htm>.

aspects in various projects aimed at achieving their goals. For example, WHO has provided guidance for health impact assessments for energy policies and projects. FAO implements rural energy projects aimed at promoting sustainable development in rural areas, usually with a focus on agriculture.

### **III. Extent of cooperation and coordination of activities within the United Nations system in the field of energy**

6. The General Assembly, at its nineteenth special session, held in 1997, stressed the need for strengthening international cooperation, especially with regard to assisting developing countries in providing energy services to all; evolving commitments with regard to the transfer of technology to developing countries and economies in transition; promoting research on and development of renewable energy technologies and, with respect to fossil fuels, cleaner technologies; and the encouragement of policies aimed at promoting the internalization of environmental costs so as to achieve a more sustainable use of energy (see A/S-19/29). It was agreed that the Commission on Sustainable Development, at its ninth session, to be held in 2001, would address those issues, with "Energy/atmosphere" as the sectoral theme and "Energy/transport" as the economic sector/major group.

7. The General Assembly also stressed the need for encouraging better coordination in the field of energy within the United Nations system, and agreed that, *inter alia*, the work of the Committee on Energy and Natural Resources for Development should be more compatible and supportive of the work of the Commission on Sustainable Development.

8. An Ad Hoc Inter-Agency Group on Energy was constituted in March 1996 to coordinate energy-related activities within the United Nations system, and met in October 1997 prior to the initiation of preparations for the ninth session of the Commission to discuss preparations at the inter-agency level. In addition, an informal meeting to follow up the recommendations of the General Assembly at its special session on the overall review and appraisal of the UNCED commitments was held in Vienna in October 1997.

9. The Ad Hoc Inter-Agency Task Force on Energy was formally established in 1998 by the Inter-Agency Committee on Sustainable Development (IACSD) to facilitate coordination and cooperation among United Nations entities in energy and related areas in preparation for the ninth session of the Commission. The Task Force reports directly to IACSD and replaces the informal Inter-Agency Group on Energy.

10. The Task Force met on three occasions in 1999 and 2000 to elaborate a common system-wide approach to energy and sustainable development that facilitates the coordination of activities in the preparation for the ninth session of the Commission. All United Nations entities/agencies involved in energy and energy-related issues have participated in the sessions and, as part of preparations for the ninth session of the Commission, the Task Force has participated in the work of the Committee on Energy and Natural Resources for Development and of the Ad Hoc Open-ended Group of Experts on Energy and Sustainable Development.

11. The Task Force has drawn on the work of the former Inter-Agency Group on Energy to elaborate a common system-wide approach to energy within the United Nations system. It has agreed on general principles for a common system-wide approach, including inclusiveness, complementarity of activities, coordination and information-sharing, and consideration of the advantages and disadvantages of all energy options from a social, economic and environmental perspective. The Task Force has further agreed that work in this area should include the following main elements:

(a) The importance of collection, processing and analysis of data on energy and of dissemination of information;

(b) Policies to ensure harmonization of short and long-term goals for the development and use of energy within a sustainable energy framework;

(c) Identification and strengthening of linkages among economic, social and environmental issues, including ways and means of internalizing external environmental costs associated with energy production and use;

(d) Conversion of broad policy frameworks into specific operational strategies;

(e) Ensuring adequate energy services for both rural and urban households, especially in developing countries;

(f) Establishing and strengthening institutions and building capacity for developing sustainable energy futures;

(g) Access to financing and credits for capacity development and transfer of relevant technologies for sustainable energy.

In addition, the Task Force has agreed that the key issues identified by the Group of Experts at its first session, in February 2000 — the accessibility of energy, energy efficiency, renewable energy, advanced fossil fuel technologies, nuclear energy technologies, rural energy and energy-related issues in transportation, along with the cross-cutting issues of capacity-building, technology transfer and financial resources — are important components of the common system-wide approach.

12. To promote better cooperation and transparency, a matrix of activities has been prepared, a "living document" which is updated continuously as a reference for United Nations entities/agencies and to assist them in the coordination of their activities. Reports of the sessions and the matrix are available upon request and are posted on the Department of Economic and Social Affairs web site at: <http://www.un.org/esa/sustdev/iaenr.htm>. The most recent version of the matrix will be made available to the Committee at its second session.

13. Although the present report does not attempt to assess the impact of activities undertaken, those reported in the matrix are executed in line with the objectives of sustainable development and as part of United Nations efforts to implement Agenda 21. The table shows that virtually every United Nations agency/entity undertaking activities in the field of energy is cooperating with other agencies/entities. Cooperation on a continual basis, effected through electronic communications between formal meetings of the Task Force, has enabled agencies to avoid duplication of effort, and many activities undertaken now complement related activities rather than overlap with them. Cooperation with organizations outside the United Nations system is a feature of some projects as well, such as that of the world energy assessment undertaken by United Nations Development Programme (UNDP) and the Department of Economic

and Social Affairs, together with the World Energy Council.

## IV. Conclusions and recommendations

14. Cooperation in the field of energy within the United Nations system has been undertaken on a formal basis since 1998 and with a view towards working more efficiently in preparing for the ninth session of the Commission on Sustainable Development. The Ad Hoc Inter-Agency Task Force on Energy has facilitated the coordination of energy activities, and has been successful in its initial efforts, especially with regard to establishing a common system-wide approach to energy and sustainable development and facilitating communication and exchange of information on a regular basis. The continuation of the Task Force or the establishment of a similar mechanism beyond 2001 could prove useful as a means of ensuring continued cooperation on a permanent basis.

15. Efforts at cooperation with agencies outside the United Nations system working in the field of energy would further enhance overall cooperation in the area of energy.

### Notes

<sup>1</sup> See *Official Records of the Economic and Social Council, 1999, Supplement No. 12 (E/1999/32)*, chap. I.B., draft decision II.

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Item 7 of the provisional agenda\*

Follow-up to the first session of the Committee

**Follow-up to the first session of the Committee on Energy  
and Natural Resources for Development: energy sector****Report of the Secretary-General****Contents**

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\* E/C.14/2000/1.



## I. Introduction

1. At its first session, in April 1999, the Committee on Energy and Natural Resources for Development requested the Secretary-General to prepare a report on follow-up to the first session of the Committee, for consideration by the Committee at its second session in 2000.<sup>1</sup> The Economic and Social Council, at its substantive session of 1999, approved the provisional agenda and documentation for the second session of the Committee; the present report on follow-up activities in the energy sector has been prepared in response to that request.

## II. Main decisions and recommendations of the Committee

2. At its first session, the Committee, following deliberations by its energy sub-group, adopted a decision to be brought to the attention of the Economic and Social Council on its contribution to the preparatory process for the ninth session of the Commission on Sustainable Development, the sectoral theme of which will be "Atmosphere/energy", while in the economic sector "Energy/transport" will be deliberated upon. In its contribution, the Committee identified the seven most critical issues that require urgent attention during the preparatory process, particularly by the Ad Hoc Open-ended Intergovernmental Group of Experts on Energy and Sustainable Development and by the Commission. The Committee also discussed the different options for a sustainable energy future and identified six options that should have special attention. Also, the Committee considered different policies and measures that should be implemented to achieve a sustainable energy future.

3. The Committee also made recommendations concerning the outcomes of the ninth session of the Commission, *inter alia*, to create better understanding on and approaches to energy and sustainable development issues for the new millennium, recognize outstanding development issues and constraints to sustainable energy development and initiate a mechanism to promote commonly acceptable recommendations on best practices for achieving a sustainable energy future for all.

4. The Committee recommended that the Economic and Social Council (a) bring forward the dates of the second session of the Committee to 14 to 25 August 2000 so that the Committee could continue to contribute usefully to the preparatory process for the ninth session of the Commission and (b) approve the report of the Committee on its first session and the provisional agenda and documentation for the second session.<sup>1</sup>

## III. Follow-up to the decisions of the Committee and related initiatives

5. At its seventh session, which was held from 19 to 30 April 1999 immediately after the first session of the Committee, the Commission on Sustainable Development recommended that the Economic and Social Council transmit the report of the Committee on its first session to the Commission at its eighth session, as well as to the Ad Hoc Open-ended Intergovernmental Group of Experts on Energy and Sustainable Development at its first session, as an input to the preparatory process for the ninth session of the Commission.<sup>2</sup>

6. In its resolution 1999/276, the Council decided that the dates of the second session of the Committee should be brought forward as recommended by the Committee, after which the Committee would continue to meet biennially, with its third session to be held in 2002. In its resolution 1999/277, the Council took note of the report of the Committee on its first session and decided to transmit it to the Commission on Sustainable Development. The Council also approved the provisional agenda and documentation for the second session of the Committee and invited the United Nations Secretariat and other relevant organizations involved to incorporate, as far as possible, the reporting requirements for the Committee in their ongoing and planned work to support the Commission on Sustainable Development.

7. The Ad Hoc Inter-Agency Task Force on Energy met on three occasions in 1999 and 2000 to elaborate on a common system-wide approach to energy and sustainable development that facilitates the coordination of activities in the preparation for the ninth session of the Commission. All United Nations entities and organizations involved in energy and energy-related issues have participated in the sessions

and, in addition to preparations for the ninth session of the Commission, the Task Force has coordinated work associated with the Committee on Energy and Natural Resources for Development and the Ad Hoc Open-ended Intergovernmental Group of Experts on Energy and Sustainable Development. A matrix of activities has been prepared as a "living document" which is updated continuously as a reference for United Nations entities and agencies to aid in the coordination of activities. Reports of the sessions and the matrix are posted on the web site of the Department of Economic and Social Affairs of the United Nations Secretariat at: <http://www.un.org/esa/sustdev/iaenr.htm>. Coordination of activities is reported in more detail in the report of the Secretary-General on the coordination of energy activities within the United Nations system (E/C.14/2000/6).

8. The Ad Hoc Open-ended Intergovernmental Group of Experts on Energy and Sustainable Development met for its first session from 6 to 10 March 2000. For the consideration at the Meeting, two reports of the Secretary-General were submitted, entitled "Energy and sustainable development: key issues" (E/CN.17/ESD/2000/3) and "National submissions" (E/CN.17/ESD/2000/2). In the preparation of the key issues paper, the contribution of the Committee to the preparatory process for the ninth session of the Commission on Sustainable Development was taken into careful consideration. The Secretary-General's report identified the following key issues for consideration by the Group of Experts: (a) accessibility of energy, (b) energy efficiency, (c) renewable energy, (d) advanced fossil fuel technologies, (e) nuclear energy technologies, (f) rural energy, (g) energy and transportation, (h) technology transfer, (i) capacity-building, (j) mobilization of financial resources and (k) international and regional cooperation. The Co-Chairpersons' summary of the discussion at the first session of the Group of Experts and the provisional agenda for the second session are contained in the report of the Group of Experts on its first session (E/CN.17/2000/12). Item 2 of the provisional agenda for the second session should be of major interest to the energy sub-group of the Committee; it reads as follows:

2. Consideration of the key issues of energy for sustainable development, with due consideration given for each issue to the means of implementation: capacity-

building, technology transfer and financial resources:

- (a) Accessibility of energy;
- (b) Energy efficiency;
- (c) Renewable energy;
- (d) Advanced fossil fuel technologies;
- (e) Nuclear energy technologies;
- (f) Rural energy;
- (g) Energy-related issues in transportation.

9. The report of the Group of Experts on its first session was submitted to the Commission at its eighth session. The Commission noted with interest the critical issues in energy for sustainable development discussed in the report and urged countries to contribute to the preparatory process for the ninth session of the Commission. The Commission adopted the draft provisional agenda for its ninth session, and a number of items of the draft agenda should provide direction to the work of the Committee at its second session, particularly the work of its energy sub-group, namely items 3 (Energy), 4 (Atmosphere) and 5 (Transport).

10. In the Secretary-General's report on the World Solar Programme 1996-2005 (A/54/212), the relationship of the World Solar Programme to the Programme for the Further Implementation of Agenda 21 and the international coordination and cooperation carried out under the World Solar Programme were outlined. The report also provided information on the implementation of the World Solar Programme, including projects established, activities carried out, those being planned and publications. In its resolution 54/215, the General Assembly took note with appreciation of the above-mentioned report on the World Solar Programme and, *inter alia*, decided to include in the provisional agenda of its fifty-fifth session the sub-item "Promotion of new and renewable sources of energy, including the implementation of the World Solar Programme 1996-2005" under the item "Environment and sustainable development".

11. The World Energy Assessment a joint endeavour of the United Nations Development Programme (UNDP), the Department of Economic and Social

Affairs and the World Energy Council, has progressed to the final stage of the editorial process. WEA provides a scientific evaluation and review of what is known about energy trends and their relationship to the world's future. It aims at providing an objective evaluation of the social, women, population, poverty, lifestyles, urbanization, economic, environmental (local, regional, and global) and security issues linked to energy, and identifying and assessing options for sustainability in each of these areas. WEA will serve as one of the inputs to the preparatory process for the ninth session of the Commission on Sustainable Development.

12. During the editorial process of WEA, consultations were held at different levels, including regional dialogues (Africa, Asia, Latin America, Arab States, Europe), NGOs (environmental, consumer, advocacy groups), the scientific and technological community, financiers and private sector interests, and policy makers, as well as a South-South/North-South exchange. In addition to those consultations, a series of outreach activities and high-level regional meetings have been planned that are aimed at wider dissemination of the findings of WEA, thereby aiding the consensus-building process for sustainable energy strategies. Briefing notes and discussion papers based on the consultations and key findings of the editorial process are also envisaged as inputs to the ninth session of the Commission on Sustainable Development.

13. Technical cooperation activities in energy — during the period between the first and second sessions of the Committee — addressed climate change issues on several fronts. The scope of cooperation included:

(a) Regional air pollution monitoring and modelling, introduction of cleaner fossil fuel combustion technologies and a clean cities initiative;

(b) Integrated resource planning and demand-side management to assist electric utility companies;

(c) Energy efficiency standards and labelling for end-use equipment and appliances, chlorofluorocarbon-free refrigerator programmes, energy audits and promotion of energy service companies;

(d) Renewable energy development, including capacity-building through training, supporting policies and frameworks for commercialization, entrepreneur

development, standards and best practices, master plans and pilot projects, with a focus on energy services for rural areas and small island developing States;

(e) Energy recovery from solid waste, including landfill gas, solid waste management and environmental standards;

(f) A global initiative on transport energy with the World Bank, addressing transport energy planning, traffic management, road pricing, alternative fueled vehicles, emissions testing and mass transit.

## IV. Conclusions

14. The recommendations of the Committee in the energy sector, particularly the contribution to the preparatory process for the ninth session of the Commission on Sustainable Development, have had a tangible influence on activities in energy and related areas in the United Nations system. The critical issues raised by the Committee in achieving a sustainable energy future have been well received by the Economic and Social Council, the Commission on Sustainable Development at its seventh and eighth sessions, and the Ad Hoc Open-ended Intergovernmental Group of Experts on Energy and Sustainable Development. Those critical issues were also taken into careful consideration in the report of the Secretary-General entitled "Energy and sustainable development: key issues" (E/CN.17/ESD/2000/3), which was well received by the Group of Experts.

15. Consistent with the recommendation of the Committee, the critical role of accelerated development and the application of environmentally sound energy technologies to meet the growing demand for energy for sustainable development worldwide has gained increasing importance in debates and deliberations in all energy-related forums, as evidenced in the increased use of those technologies in the production, conversion and use of energy resources.

## Notes

<sup>1</sup> See *Official Records of the Economic and Social Council 1999, Supplement No. 12, E/1999/32*.

<sup>2</sup> See *Official Records of the Economic and Social Council, 1999, Supplement No. 9, E/1999/29*.